

# ***SIGNAL***



September 1960

*orbit*

*launch*

*suspense*



*Project Transit*

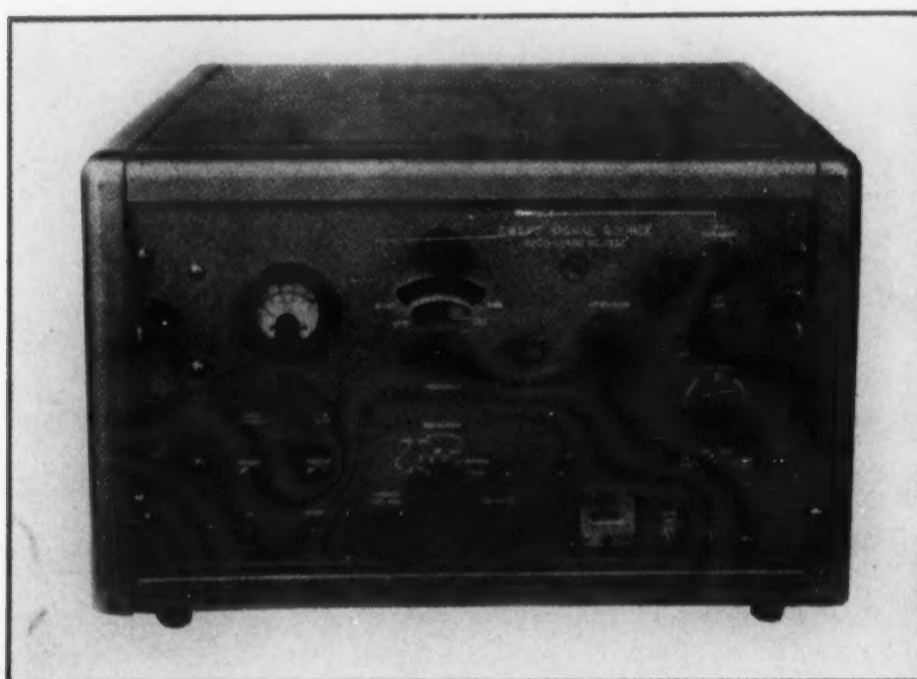
*See page 18*





# X-BAND SWEEP SIGNAL SOURCE

8,200mc to 12,400mc Frequency Range



## Advanced Features Include:

- ☒ ELECTRONIC SWEEP
- ☒ AUTOMATIC GAIN CONTROL
- ☒ DIRECT READING  
FREQUENCY DIALS

*"If a man's work be true and good...challenging comparison will be his strength."*

*David Charles*

The FXR Model X775A X-Band Sweep Signal Source, challenging comparison, is unsurpassed for the measurement of VSWR and reflection coefficient. The Model X775A utilizes a permanent magnet BWO as the rf source. A unique built-in AGC amplifier produces a flat rf level, with respect to a bolometer detector, over the entire swept frequency range. Both ends of the swept frequency range can be accurately preset on separate direct reading frequency dials.

### Specifications for the FXR Model X775A:

- **FREQUENCY RANGE:** 8,200mc to 12,400mc.
- **SWEEP RATE (RESOLUTION):** 300mc/sec to 300kmc/sec, linear with time.
- **SWEEP WIDTH:** to 4,200mc, direct reading, continuously adjustable.
- **OUTPUT TYPES:** cw, square wave modulation (internal 800cps to 1,200cps).
- **OUTPUT POWER:** 0 to 20mw minimum cw into matched load, continuously adjustable. With AGC-detected output flat to  $\pm 0.5$ db (when used with matched bolometers and directional couplers).
- **FREQUENCY DIAL ACCURACY:**  $\pm 1\%$  — fixed frequency operation (at specified grid voltage).  
 $\pm 2\%$  — sweep frequency operation.
- **OUTPUT CONNECTOR:** 1 X  $\frac{1}{2}$  waveguide.
- **POWER REQUIREMENTS:** 115/230V, 50/60cps, 200 watt.
- **DIMENSIONS:** 12  $\frac{7}{8}$ " high X 21  $\frac{3}{4}$ " wide X 18" deep.
- **WEIGHT:** 78 lbs.

*For more details,  
contact your FXR representative.*



## FXR, Inc.

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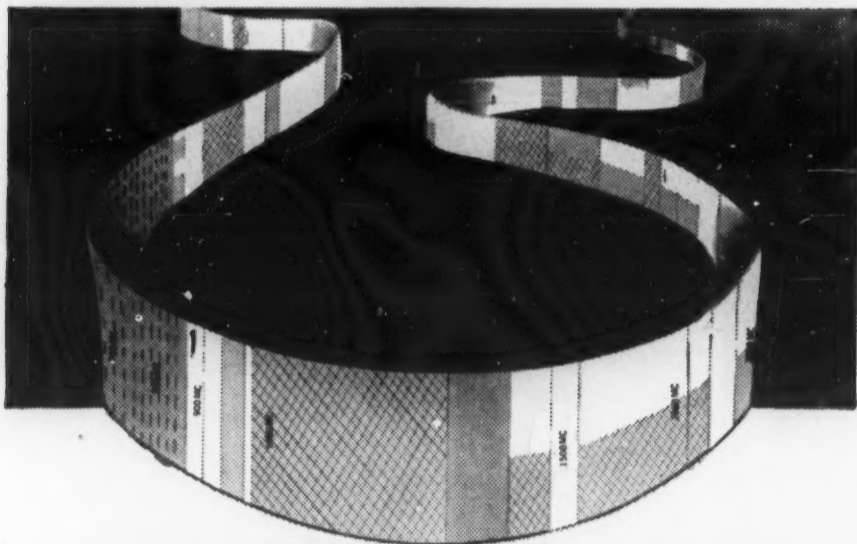
Precision Microwave Equipment • High-Power Pulse Modulators • High-Voltage Power Supplies • Electronic Test Equipment



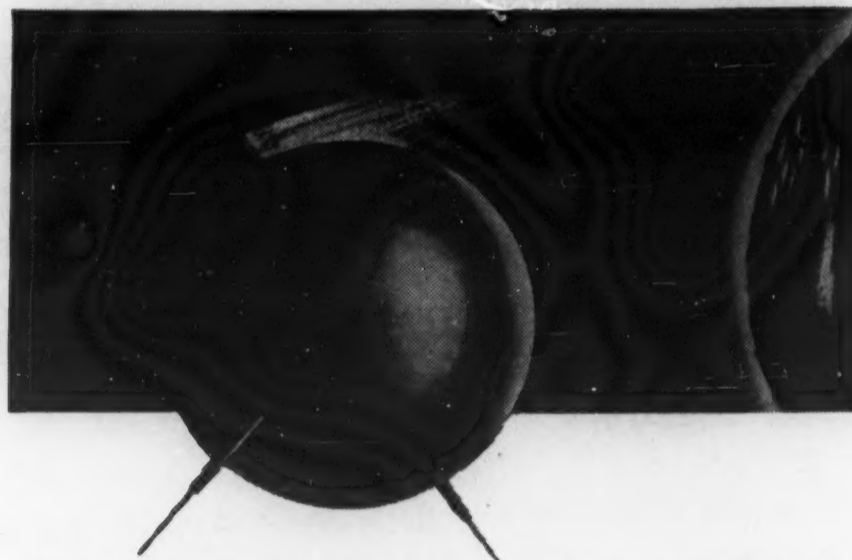
## TRANSPORTABLE TROPOSPHERIC SCATTER SYSTEM

# THE BIG **A** LEADS THE WAY TO *INTEGRATED* COMMUNICATIONS SYSTEMS

A new concept in continent-spanning tropospheric scatter communications soon will be available to the U.S. Air Force. For the first time, the full multichannel capability and reliability of a large, fixed installation will be provided in a compact, air-ground transportable package. The all-environment, 10kw, AN/MRC-85 is being designed and manufactured by ADLER under subcontract to Page Communications.



**SPECTRUM-STRETCHING COMMUNICATIONS SYSTEM** — ADLER heterodyne repeater techniques have opened a wide range of UHF channels for U. S. Army field communications, and prevented obsoleting of millions of dollars of VHF equipment. Developed and manufactured by ADLER, the "F-Head" converter permits the basic AN/TRC-24 VHF system to be used for UHF relaying in areas where VHF spectrum congestion is a problem. Designed for plug-in use, the compact "F-Head" heterodynes the VHF output of the AN/TRC-24 to the available UHF range. ADLER heterodyne techniques also are used in advanced TV microwave and repeater systems, and multichannel communications.



**SATELLITE RELAY SYSTEM** — A reliable, worldwide network for telegraphy and teletype communications will be realized through PROJECT COURIER of the Advanced Research Projects Agency and U. S. Army Research & Development Laboratories. Each of the Courier's air-ground transportable stations duplex transmit and receive 15 million bits of stored information in the 4-minute contact with the satellite. As subcontractor to ITT Laboratories, ADLER is responsible for design, manufacture and equipment installation of the ground station trailers of this earth-satellite relay system.

Write for all the facts on how ADLER experience can help solve your communications problems.

# ADLER

ADLER ELECTRONICS, INC. New Rochelle, N. Y.

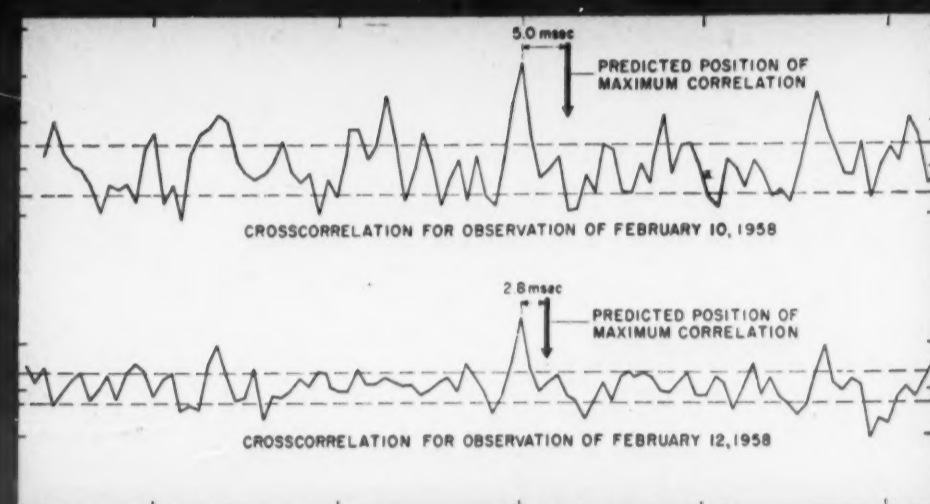
## Radar Echoes from Venus...

Continental Electronics' giant transmitter at M.I.T. Lincoln Laboratory is the most powerful on earth. With it, man has made his first contact with another planet — by bouncing a radar signal off Venus for a space round trip of 56,000,000 miles.

This is a significant forward step since it means we have pushed our radio signals a hundred times further than ever before. It means we can measure space distances with amazing new accuracy. The powerful pulses from this transmitter were beamed into space from a huge antenna 84 feet from rim to rim. It is the same radar used to sight and track earth satellites and for other space probe programs.

Continental Electronics is proud indeed to be part of this 56 million mile broadcast.

*Another Continental Electronics Contribution in Super Power Radio*



Correlation curves showing radar returns from Venus. The central peaks indicate the exact time of the radar waves from Earth to Venus and back (about five minutes). Each peak is the result of elaborate calculations by a high-speed digital computer on many thousands of tiny echoes originally beamed by Continental Electronics' transmitter

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NUMBER 1

## CONTENTS

|   |    |
|---|----|
| Frequency Allocations for Space Communications                | 7  |
| SIGNAL Staff Report   |    |
| The Role of a Non-Profit Corporation in Defense               | 12 |
| C. W. Halligan  |    |
| The Transit Navigation System                                 | 18 |
| M. A. Schreiber   |    |
| Tribute to General John J. Pershing                           | 22 |
| Eyes on the Satellites  | 23 |
| Anne Melson Stommel   |    |
| Evaluation of the Shielding Effectiveness of BMEWS Structures | 25 |
| J. J. O'Neil  |    |
| Pacific Scatter Communications System                         | 29 |
| Esterly C. Page   |    |
| What's Over the Sun?  | 31 |
| Dr. Edith J. Tebo   |    |
| Project Echo  | 37 |
| Globecom IV   | 44 |
| SIGNAL Staff Report   |    |
| Lithocom—Underground Communications System                    | 45 |
| SIGNAL Staff Report   |    |

## COVER

An Air Force Thor-Able-Star is shown at moment of blast-off on June 22, 1960. The launch vehicle successfully placed the Transit 2A satellite (upper right) into orbit. At lower left, Dr. R. B. Kershner, director of the Transit technical program, Applied Physics Laboratory, The Johns Hopkins University, waits for a report from Cape Canaveral.

## DEPARTMENTS

|   |    |
|---|----|
| Signalgram                              | 14 |
| Association Affairs                     | 50 |
| New AFCEA Members                       | 52 |
| Sustaining and Group Member Directory   | 54 |
| Chapters and Chapter Officers Directory | 56 |
| Chapter News                            | 58 |
| News Items and New Products             | 60 |
| Photoprogess                            | 65 |
| Names in the News                       | 66 |
| Index to Advertisers                    | 68 |

# ALDEN SCANNERS MARK NEW ERA IN FACSIMILE COMMUNICATIONS



*Compact, mobile Alden Flat Copy Scanners are in use today throughout the U. S. Weather Bureau Hi-Altitude Facsimile Network — marking a bright new era of simplified, continuous facsimile communication. And here are the reasons why —*

**NEW INSTALLATION SIMPLICITY . . .** within two hours of air delivery, Alden Scanners at the Hi-Altitude Network were uncrated from their fold-away shipping cases, rolled in, plugged in, and *fully tested* for 60, 90, and 120 RPM quiet and dependable operation.

**NEW COPY HANDLING SIMPLICITY . . .** map transmission is no longer dependent on exact drum mounting. With Alden's expandable copy feed head, maps of *any width or length* can be scanned, one after the other, fed straight or crooked, *with only one Alden Scanner*. Original plotted maps can now be scanned without cutting to size. Map plotters have originals returned in half the time. Space and maintenance problems are minimized.

**NEW CLARITY — NEW SHARPNESS . . .** with copy feed rolls precisely positioning surface of the map on the flat copy scanner table, exact focal lengths are maintained for clear, sharp recordings. Focus smudge caused by unusually thick copy or copy lifting from drum is *completely eliminated*.

**MEETS ALL FUTURE REQUIREMENTS . . .** the practical scanning equipment for a world-wide facsimile map network. Speeds can be easily increased — without reengineering of equipment — for use with coaxial or microwave transmission facilities and computer-processed weather data.

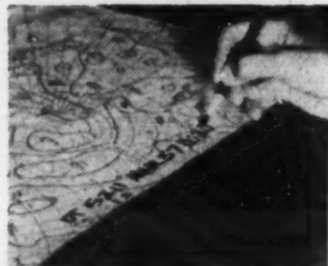
**WHAT ARE YOUR FACSIMILE REQUIREMENTS? LET'S GET TOGETHER . . .** Alden Flat Copy Scanners and Recorders are available in all sizes (and up to 30 times present network speed) to users and qualified manufacturers. Your inquiry is invited.

## HERE'S WHY FORECASTERS PREFER\* ALDEN RECORDERS AND ALFAX MAPS AND WHY WE THINK YOU'LL LIKE THEM TOO!

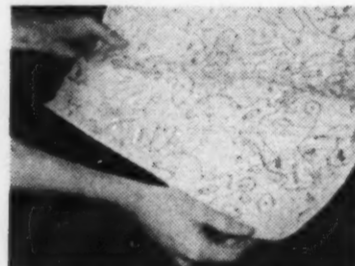
### MOST COMMENDED FEATURES OF ALFAX MAPS



Color Is Easiest To Read Under All Lighting Conditions



Ease Of Writing And Erasing Enhances Analysis



Clean Crisp Duplicates By Bruning Or Ozalid

\* In surveys of weather forecasters experienced with all weather facsimile systems, 3 out of 4 indicated a marked preference for Alden Recorders and Alfax Maps.

### PLUS THESE UNIQUE FEATURES

**LOW COST . . .** Alfax papers save 1/3 to 2/3 yearly paper costs.

**CLEAN . . .** Electricity is the Ink . . . ion deposits make crisp brown marks on clean white background — free from dust, smudge and chemical irritants.

**PERMANENCE . . .** Alfax stores indefinitely . . . recording marks are permanent.

### MOST COMMENDED FEATURES OF ALDEN RECORDERS

**EASE OF INSTALLATION**  
Compact, mobile, and ready for immediate operation.

**EASE OF OPERATION**  
A new high in clean, quiet, trouble-free operation



Uncrate



Roll in

**EASE OF MAINTENANCE**



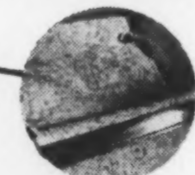
Front panel checks



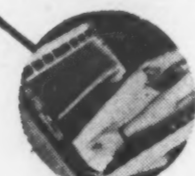
Back connector checks



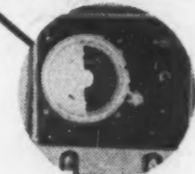
Plug-in construction



Instant Visibility



Easy Paper Loading



Automatic Time-Clock Programming

### PLUS THESE UNIQUE FEATURES

**SECURITY . . .** Low voltage marking process does not generate a signal that can be intercepted.

**HIGH SPEEDS . . .** Sixty, 90 or 120 RPM operation — recorder technique and paper capable of 15 times these existing speeds.

**VOLUME PRODUCTION . . .** Designed for volume production on short lead time through unique expandable manufacturing processes.



### CEILOMETER BREAKTHROUGH

Used with rotating beam ceilometer, Alfax paper and Alden recording techniques replace continuous live scope observation with a continuous pictorial history of cloud conditions. Dynamic tone-shade gradients in warm color reveal all pertinent ceiling information in easy-to-read, easy-to-interpret form. Superimposed dark maximum signal marking shows exact reportable cloud height.

**ALDEN ELECTRONIC AND IMPULSE RECORDING EQUIPMENT CO., INC.**  
Alden Research Center Westboro, Mass.

# HIGH POWER IN SMALL PACKAGES

**A COMPLETELY NEW DESIGN CONCEPT IN MOBILE COMMUNICATIONS... Here is a LINEAR AMPLIFIER package that takes low exciter power, converts it to 1000 watts PEP and delivers the RF directly into a conventional whip antenna.**

The DM1000A is a single tube liquid cooled Linear Amplifier operating in Class AB<sub>2</sub>. Cooling is accomplished by a small amount of recirculating coolant. Pump and heat exchanger are an integral part of the base and no external liquid connections are required. Normally supplied in a passive grid configuration, it is also available as a grounded grid amplifier where use of more exciter power is desired. The output circuit is unique—there is no tank tuning in the ordinary sense. The antenna working through the ground system provides the required capacity. Peak antenna adjustment is made possible through use of a Jennings variable vacuum capacitor. The Amplifier is sufficiently broadband to cover a wide range without retuning and with little attenuation. A conventional 96-inch whip antenna is satisfactory on all frequencies. The system requires no base loading and puts the RF power where it is most useful. Multi-band operation from 6 to 60 MC is attained through easily interchangeable plug-in units.

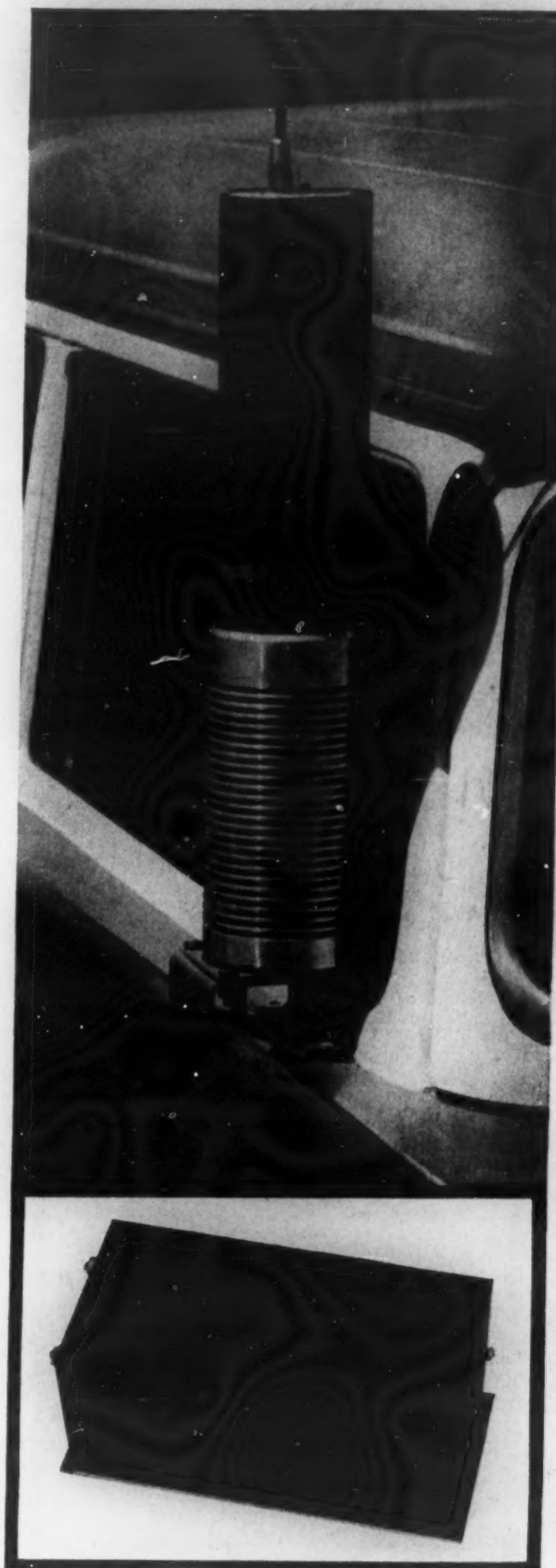
The DMP1012A is a highly efficient solid state inverter that operates from a 12 volt DC source and supplies the plate, screen and bias voltages for the DM1000A. It is capable of 1000 watts output ICAS and has many applications. Test points are provided as part of the inverter for monitoring plate voltage, plate current, screen voltage and bias.

## TECHNICAL INFORMATION

| DM1000A Linear Amplifier   | DMP1012A Inverter       |
|--|-------------------------|
| Plate: 2500V.  | Output: 2500V. at 400MA |
| Screen: 350V.  | 350V. at 100MA          |
| Bias: -60V.  | -40 to -80V. adjustable |
| RF Bandwidth: Flat for 100KC at 7MC  | Input: 11 to 13V. DC    |
| Frequency Range: 6-60MC with plug in units.  | Efficiency: 85% at 1 KW |
| Excitation: Any good exciter providing a peak signal of 80 volts.<br>High power exciters should be terminated in characteristic loads. |                         |

## PRICE AND ORDERING INFORMATION

Complete package consisting of DM1000A Linear Amplifier, DMP1012A DC to DC Inverter and all power and signal cables for normal installation .....\$995.00  
Additional plug-in units DM1000A.....\$ 27.50 each



The package consists of a Linear Amplifier model DM1000A, a DC to DC inverter model DMP1012A and all power and signal cables necessary for normal installation.



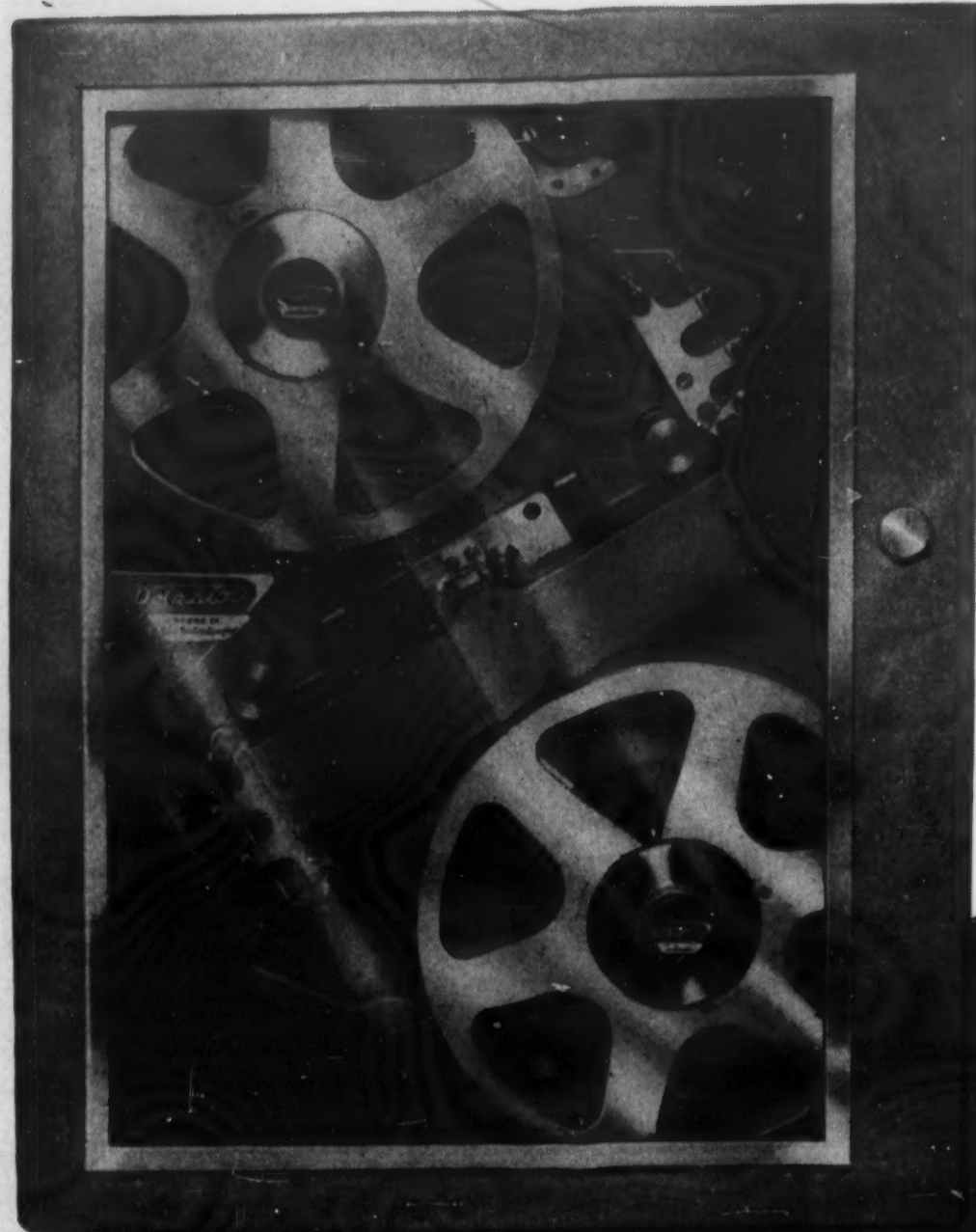
Contact your nearest dealer or write:

**YUBA-DALMOTOR DIVISION**  
1375 El Camino Real, Santa Clara, California

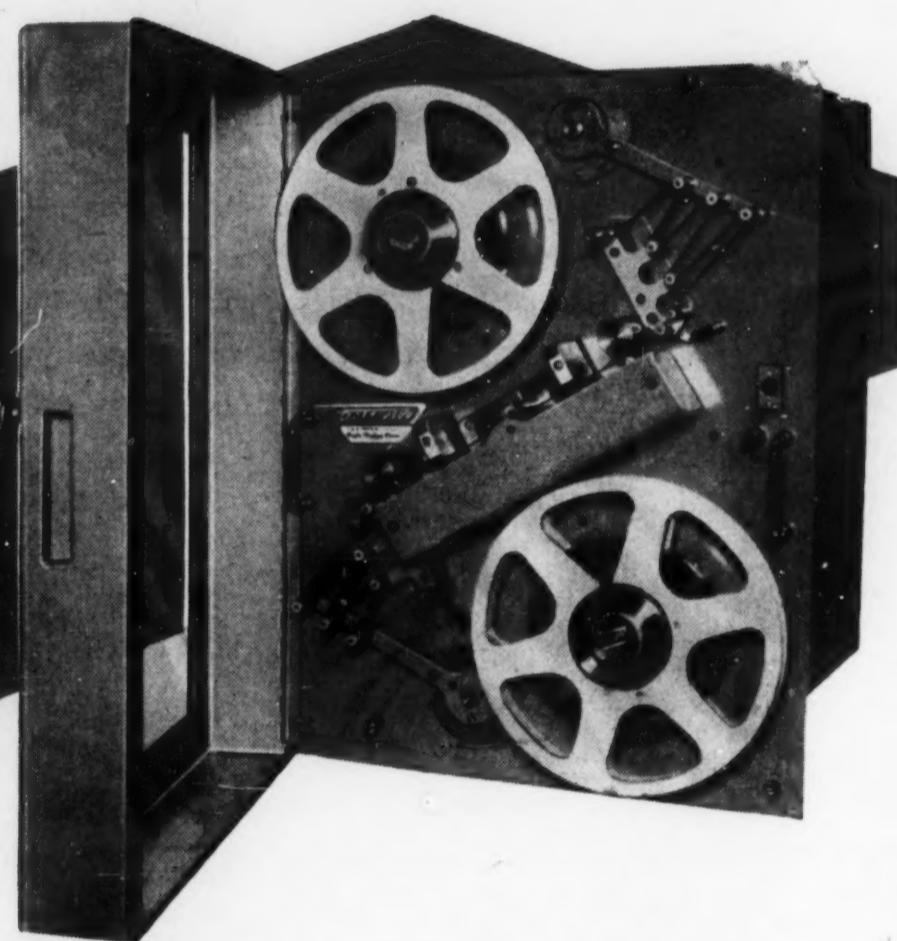
**YUBA CONSOLIDATED INDUSTRIES, INC.**

ONE OF MANY EXAMPLES  
OF EXCELLENCE IN THE DATA  
HANDLING FIELD

Cook Electric Company's  
*New*  
**DIGITAL TAPE  
TRANSPORT**



**SOLID STATE  
ULTRA RELIABLE  
HIGH PERFORMANCE  
MILITARY QUALITY**



The Data-Stor Model 59 Digital Tape Transport is ideally suited for use in computer, instrumentation and control applications. It incorporates the highly reliable features of military tape transports developed by Cook Electric Company during the past 12 years, and has been proven in the Atlas, Titan, Polaris and other missile programs.

These features include exclusive use of modern ultra reliable solid state circuitry, eliminating gas or vac-

uum tubes. Precise tape handling is insured by proportional reel drive servo systems that have no jerky step servos. Tension error sensing is accomplished by synchro transmitters with no unreliable potentiometers or contact pile-ups. Field adjustments are eliminated by building tolerances into a single rugged tape deck casting. Endurance and quality are assured by strict adherence to the exacting design and workmanship requirements of MIL-E-4158.

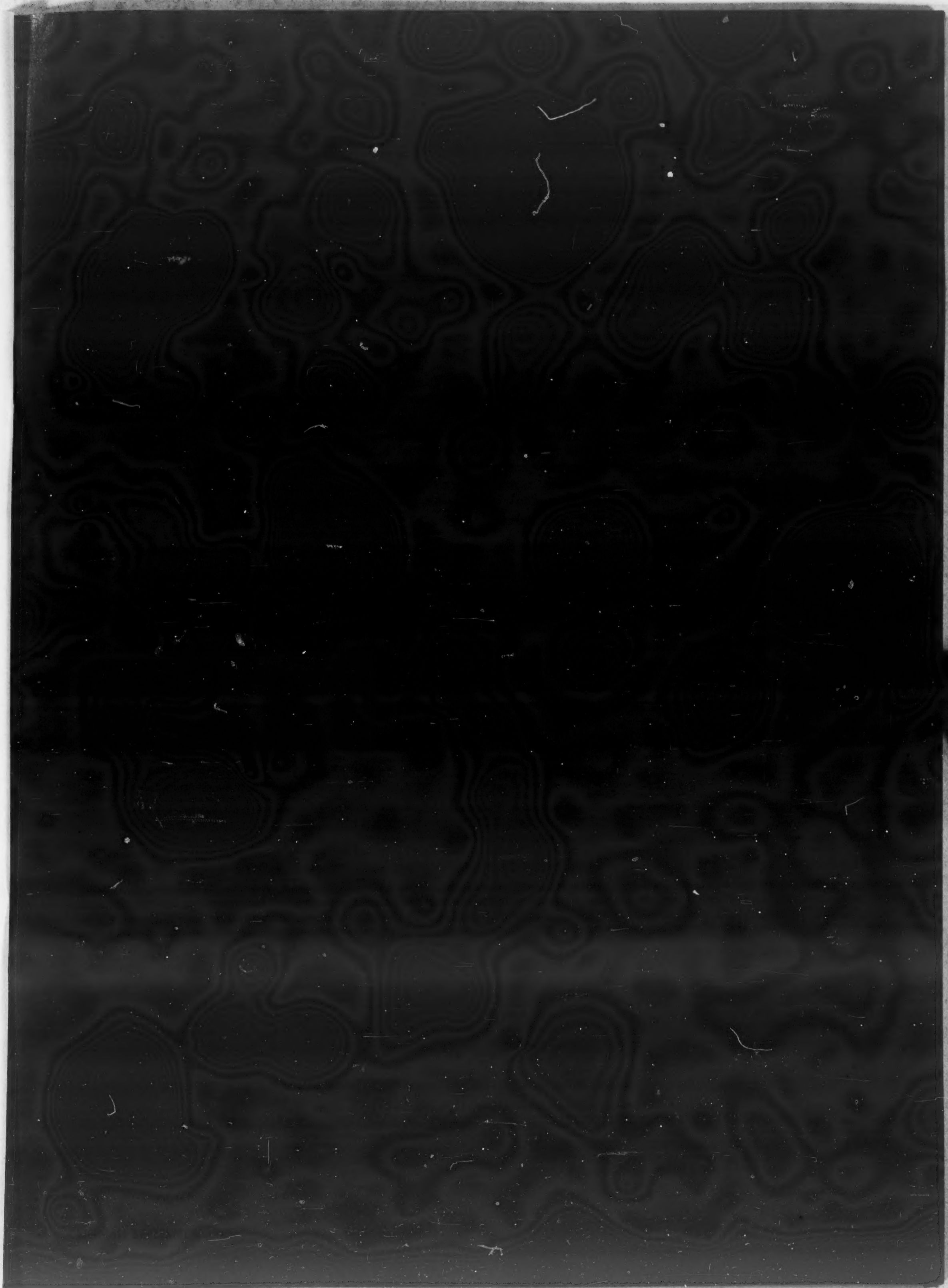
**TAPE SPEEDS TO 150 IPS . LESS THAN 3 MS STOP/START . REWIND SPEEDS TO 400 IPS . NO PROGRAMMING RESTRICTIONS . PACKING DENSITIES TO 600 NRZ BPI . OPERATES FROM 5 VOLT CONTROL PULSES OR LEVELS OF EITHER POLARITY . FRONT PANEL ACCESS . CHOICE OF NARTB, IBM, OR SPECIAL REELS . ANY TAPE TO 1" . CONDUCTIVE LEADER, LIGHT TRANSMISSIVE, OR LIGHT REFLECTIVE END OF TAPE SENSORS . SOLID STATE READ/WRITE AMPLIFIERS . METAL FACED READ/WRITE MAGNETIC HEADS . AVAILABLE AS HIGH SPEED PHOTOELECTRIC READER.**

Experienced recording systems engineers are invited to apply for existing employment opportunities.

A DIVISION OF  
**Cook Electric Company**

Designers and makers of ground and airborne magnetic recording systems, photoelectric readers and computer peripheral equipments.

ADDRESS YOUR INQUIRIES TO  
8100 MONTICELLO AVENUE  
SKOKIE, ILLINOIS



it is expected that the capacity of these cables may increase eventually, the cost per channel is expected to exceed by far that of a satellite system, AT&T believes.

In addition to telephone call capabilities there will be demands for both commercial and closed circuit television circuits and data circuits. It is not thought at present that cables will be able to provide the necessary bandwidth for television transmission in the foreseeable future.

A satellite system would provide all these capabilities at a lower per-channel cost than any alternative. The envisioned world-wide system would involve twenty-six ground stations and would provide 600 voice channels and one television channel each way on thirteen routes. Approximately fifty active satellites would be shared by the various pairs of stations. It would cost initially about \$170,000,000.

Frequencies below 1000 mc do not provide sufficient bandwidth for the broad band modulation technique required for adequate signal to noise ratio. The frequencies above 10,000 mc become increasingly susceptible to absorption by rain. This leaves from 1000 to 10,000 mc as the only satisfactory frequency band. Within this band, between 2000 and 3000 mc will be required for the efficient operation of a satellite communications system.

AT&T testimony on interference possibilities at these frequencies was extensive. To wit, satellite communication systems are particularly susceptible to interference of all types because of the receiver sensitivity required to receive the very weak signals returned by the satellite. They conclude that several hundred miles of separation between surface microwave systems and ground terminals would be required to assure reliable space communications, although even this separation would not ensure reliable communications in all cases. Since private microwave systems are concentrated in areas of the country where the space ground stations would be located, it would not be possible to provide this separation. Therefore, it will not be practicable for space communication systems and ground microwave or radar users to share the same frequencies.

On the basis of these conclusions, AT&T recommended that the order issued by the FCC on August 6, 1959 be rescinded, and that allocations be made on the same basis as before this order was issued. In this way, frequencies in the 1000-10,000 mc band would be reserved for space

communications and allocated as the space communications systems are developed.

Both written and oral testimony were given on behalf of AT&T by Dr. James B. Fisk, President, Bell Telephone Laboratories, Inc.; Dr. John R. Pierce, Director of Research, Communications Principles, Bell Telephone Laboratories, Inc.; Charles M. Mapes, Assistant Chief Engineer, American Telephone and Telegraph Company; Brockway McMillan, Director of Military Research, Bell Telephone Laboratories, Inc.

#### **EIA View**

In addition to AT&T's probable need for frequency allocations, there are many other requests for allocation of frequencies in the 1000-10,000 mc band. These requests come from operators of private and commercial microwave systems. In its comprehensive testimony, Electronic Industries Association represented these operators.

EIA recognizes that satellite communications systems will be a necessity in the near future, but does not believe that the operation of these systems will require exclusive use of frequencies in the 1000-10,000 mc band. Should AT&T's request be granted, it might be necessary to take frequencies away from other users to accommodate space communications systems. If this action is taken, EIA fears that certain microwave users would lose their frequency allocations. In view of this situation, EIA sets forth a detailed technical presentation showing that microwave systems and satellite communications systems can operate on the same frequencies in the 1000-10,000 mc band without interference to either system, providing reasonable systems engineering judgment is exercised in the construction of both systems.

In presenting its position, EIA examined a number of possible satellite communication systems. They conclude that state-of-the-art considerations will determine that the first system will have non-stationary active satellite repeaters. Each repeater would have a three to five thousand mile orbit and would re-transmit the signal received from the ground station with a power of one watt. Interference calculations indicate a radius of interference of 38 miles at 2000 mc and 55 miles at 6500 mc. Interference problems are lessened materially for active repeater systems because much lower transmitter power and receiver sensitivity is possible at the earth terminal.

The best system for the future may well be one using an active stationary

repeater. Its location would be fixed in relation to the earth at a point about 22,300 miles above the equator. This system would not require the elaborate ground tracking equipment needed if the satellite is in motion. Neither would the ground equipment have to be duplicated since it is not necessary to transfer from satellite to satellite in order to provide continuous service.

The limiting factor at present is providing the necessary equipment in the satellite to keep it stationary. However, the principles are known, and time should provide the necessary techniques.

While there is some potential interference, EIA concludes that certain precautions will enable ground services to exist together on the same frequencies. The main source of difficulty rises when the antenna of an earth terminal and that of a ground microwave station look at each other at the same frequency. By proper frequency selection and siting this potential interference may be eliminated. Use of a stationary satellite also aids, since the tracking antenna moves very little.

On the basis of these findings, EIA recommended that the docket be closed with no change in the order issued August 6, 1959. This would permit processing of applications from private microwave users to continue.

Written testimony was submitted on behalf of EIA by John B. Olverson, General Counsel. Dr. W. L. Firestone, Director of Engineering, Communications Division, Motorola Inc., and Dr. S. G. Lutz, Senior Staff Scientist, Hughes Aircraft Company, testified orally for EIA.

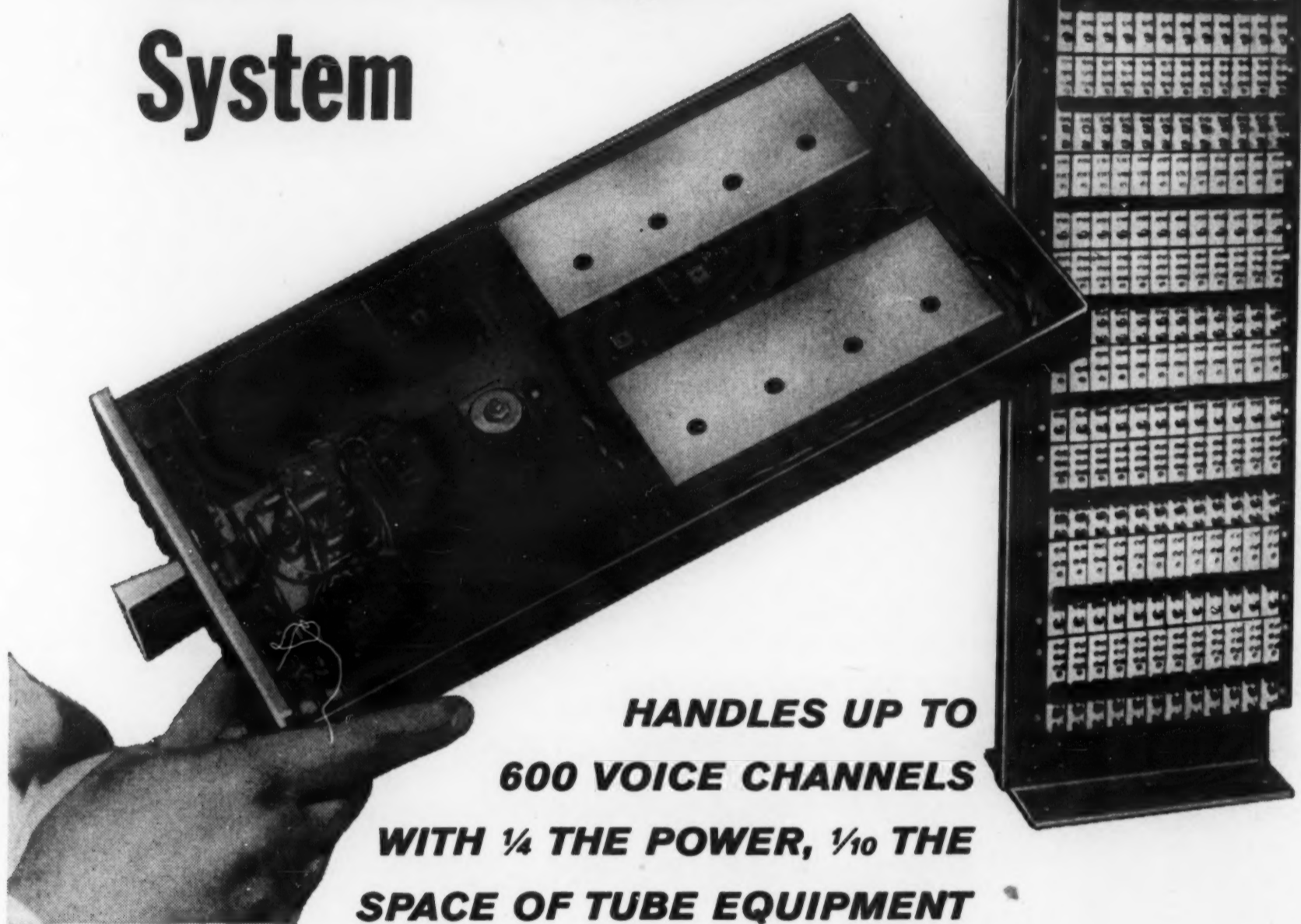
#### **GT&E Petition**

In its testimony, General Telephone and Electronics Corporation recommended that substantial portions of the region between 890 and 10,000 mc be reserved for future use by space communication systems. Dr. Edwin C. Schneider, Vice President for Research and Engineering, Sylvania Electronic Systems, submitted the written brief and testified orally before the commission.

While GT&E has no immediate plans for using communications satellites in their telephone practice, they recognize its potential as a broad band communication system and feel that adequate frequencies should be provided, with particular emphasis on reserving any necessary wide bands.

GT&E is concerned also with government and non-government use of  
(Continued on page 10)

# New General Electric Transistorized Carrier-Multiplex System



**HANDLES UP TO  
600 VOICE CHANNELS  
WITH 1/4 THE POWER, 1/10 THE  
SPACE OF TUBE EQUIPMENT**

General Electric's new TCS-600 is the world's first fully transistorized carrier-multiplex system capable of handling from one to 600 voice channels on either metallic circuits or a single radio circuit. A single sideband suppressed carrier system, the TCS-600 meets or exceeds all domestic and CCITT standards.

**Power Requirements:** The TCS-600 consumes less than 900 watts of DC power for 600 voice channels with terminations — only 8 to 25 per cent of the power needed by tube equipment. Users will realize dramatic savings in purchased power, station batteries and chargers.

**Mounting Space:** Thanks to transistorization, the TCS-600 takes only one-third to one-tenth the space occupied by conventional tube equipment. Now 600 voice channels will fit into the same area taken by 120 channels of tube equipment. You can expand at any time to full capacity without costly rewiring or building alterations.

**No Relays:** The TCS-600 is the first carrier system to

bring you the full benefits of completely static operation. No relays are used — all signalling, alarm indication and switching are accomplished by silicon controlled rectifiers or power transistors.

**Reliability:** The TCS-600 has a parallel circuit for each active circuit in the common equipment. Thus if any circuit should fail, all but a single voice channel will continue to operate via the parallel circuit.

**Long Life:** Carefully selected transistor types, operating well below recommended temperature and current ratings, assure exceptionally long life for the TCS-600. Lower operating temperatures also greatly extend the life of other components.

You'll be surprised by the low first cost and high yearly savings made possible by the TCS-600. For full details, write General Electric Company, Communication Products Dept., Section 43960, Mountain View Road, Lynchburg, Va.

**GENERAL**  **ELECTRIC**

Systems competence in design, implementation, structural construction, installation, operation, training, and maintenance of:



1. Space surveillance systems



2. Transportable electronics systems



3. Instrumentation, control, and switching systems



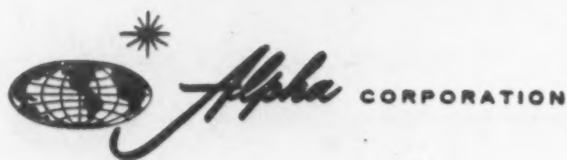
4. Telecommunications systems



5. Integrated land, sea, and air communications systems



6. Data systems



CABLE • ALPHA DALLAS

(Continued from page 8)

the same frequencies for space communications. They feel that separate frequencies should be assigned to protect important space projects. In addition, since international control is important to assure freedom from interference, action through international organizations should be taken towards agreement on allocations with other countries.

#### ARS Opinion

The American Rocket Society, represented by General Counsel Andrew Haley, believes that space projects in the next few years will require "enormous amounts of spectrum space." Therefore, ARS wants the frequencies in the 1000-10,000 mcs band left open for space communications. This group has urged radio spectrum space for astronautics activities since 1952.

#### Lockheed Statement

Representing Lockheed Aircraft Corporation, Beardsley Graham, Manager of Satellite Systems Planning, described Lockheed's satellite work to date and outlined some of the accomplishments expected in the next three to five years. He noted that within the next three years it will be possible to place one or two communications satellites in 24-hour, stationary orbits. Lockheed has not had experience with radio interference during its satellite work, since it has been using military frequencies. Therefore, the company petition does not contain any recommendation as to what the FCC should do in the way of action on its microwave policy decision.

#### Manufacturers and Truckers View

Supporting EIA's position, the joint petition of the National Association of Manufacturers and the American Trucking Associations, Inc. requests that exclusive use of frequencies in the 1000-10,000 mc band not be granted to space communications. These associations, which represent certain private microwave users, argue that the FCC should grant frequencies to proven communications systems before it grants frequencies to systems which are now in the planning stage and may not materialize for several years. They state that Docket 11866 recognized the need of private microwave systems in July 1959. However, they argue that the FCC has not granted the repeated requests of the manufacturing companies and the motor carrier industry for frequency allocations necessary to establish private

microwave systems.

Submitted to the FCC by Victor Reis, Chairman of the Committee on Manufacturers Radio Use, the petition charges that the public microwave users, specifically the telephone companies, are blocking their request for frequency allocations. The manufacturing and motor carrier groups want the FCC to close the docket without allocating frequencies for the exclusive use of space communications. Instead, they want the Commission to implement its 1959 ruling in the docket so their request for frequencies will be granted.

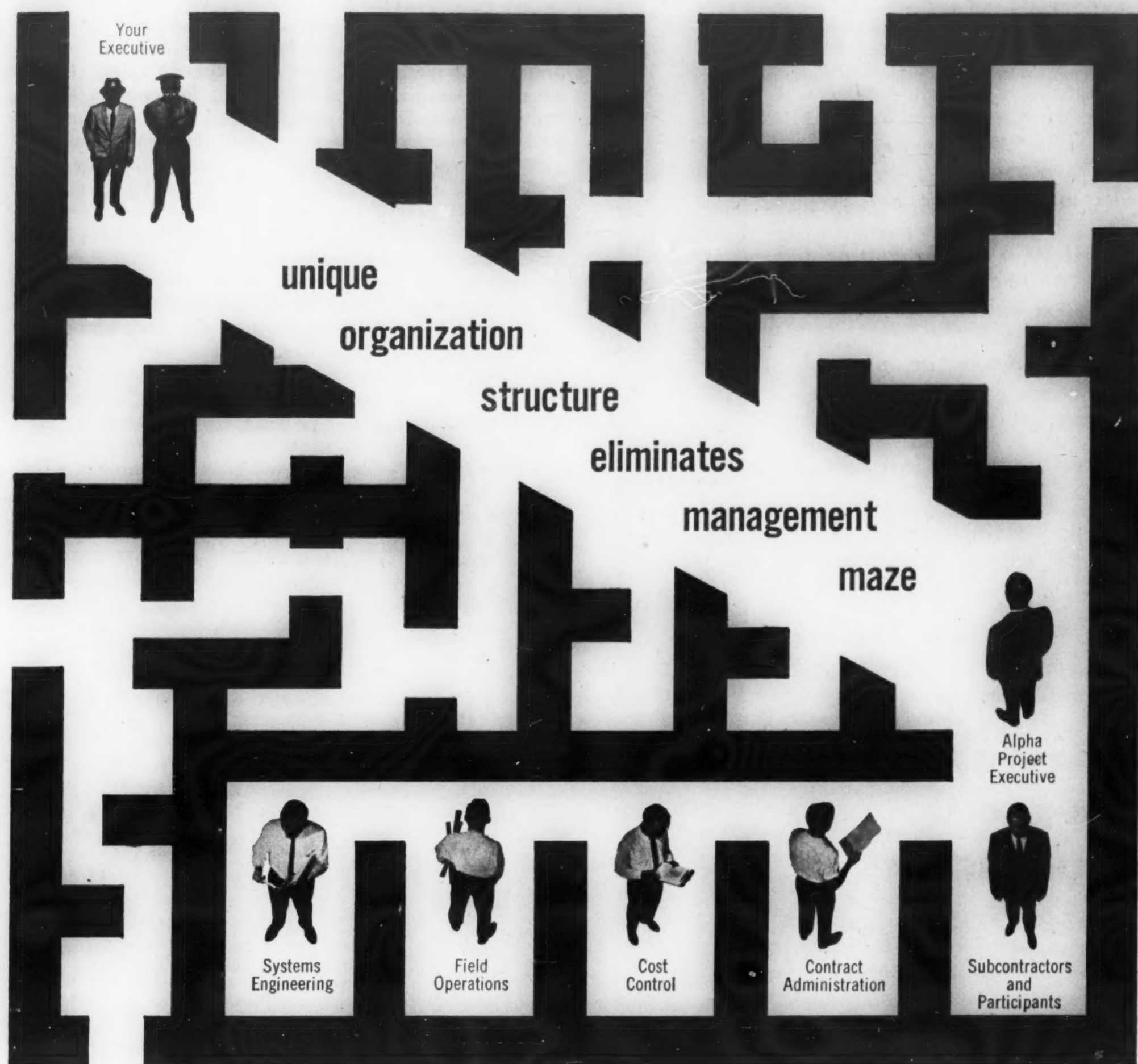
#### RCA Joint Petition

Although not present at the oral arguments, Radio Corporation of America and RCA Communications, Inc. filed a joint petition recommending that certain specific frequency bands be allocated for space communications. The recommendations totalled 2600 mc between 1000 mc and 10,000 mc. The RCA petition states that in some cases it might be possible for space communications systems to share frequencies with microwave systems. As an example, an active satellite system could share frequencies with a microwave system because of the low ground transmitter power required for the space system.

The joint petition was prepared by Robert Werner and Ray Houston, attorneys for Radio Corporation of America and Howard Hawkins and Leonard Tuft, attorneys for RCA Communications, Inc.

After studying the petitions submitted by the various groups, it is expected that the FCC will hand down its ruling on this docket sometime within the next sixty days.

Since orbiting satellites cross national boundaries, international approval must be obtained on any frequency allocations for space communications. Without this approval, many interference problems will arise. The International Administrative Radio Conference held in Geneva in 1959, under the auspices of the International Telecommunications Union, discussed the problem of space communications but did not allocate any frequencies for space communications. However, certain frequencies were allocated for space research. An Extraordinary Administrative Radio Conference to be held in Geneva in 1963 will again study the need for allocating frequencies for space communications. At this time decisions reached by the United States in this field will be presented for international consideration.



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*"Military requirements must consider not only the need for a new weapon or a new system but also its relation to other existing or planned systems."*

## **the role of a non-profit corporation in defense**

**by C. W. Halligan  
President  
The MITRE Corp.**

*The following is the text of a speech given by Mr. Halligan at the 4th National Convention on Military Electronics.*

FOR THIS TALK THE TERM "Non-Profit Corporation" will mean a private, non-profit, non-stock corporation not engaged in manufacture,—organized solely, or at least primarily, to serve the needs of the government and, more specifically, to support the country's defense effort. There are other kinds of non-profit organizations—university laboratories, foundation-supported institutes, non-

profit segments of profit-making industry, and the many agencies operated by our military services and other branches of the government. Some of the things I will have to say may also apply to some of these undertakings, but each type is to some extent unique, and I have neither the competence nor the time to explore the whole area now.

Recently the role of the non-profit corporation has been studied, and criticized, by both industry and government. I think this has been a good thing. What's more, I think such corporations should undertake a critical self-examination from time to time to make certain that they are working in appropriate areas—to see to it that they do not engage in work that should be done by industry, by government agencies, or by some of the other non-profit organizations that I have mentioned.

I think a good way to undertake an examination of this sort is to review some of the areas in which non-profit corporations are now engaged, or might conceivably be engaged; to consider the other sources that are available for this effort; and finally to determine to what extent the participation of the non-profit corporation is appropriate.

The general field of long range studies is one of these areas. One type forecasts political, social, and economic changes, and attempts to derive from this the nature and sources of future threats and our probable posture toward them. Another type deals with forecasts of technological progress and relates it to future offensive and defensive systems. There are many others.

Everybody, or almost everybody, engages in such studies. Government agencies—both military and non-military, industry, and the non-profit organizations, including non-profit corporation. If the work is done well, it will be helpful to all of us and will in no way hamper or restrict the basic functions of either government or industry. There are no strong arguments either for or against the participation of non-profit corporations, but there are some factors which make this an appropriate field for them. Government agencies find it difficult, for a number of reasons, to assemble the kinds of talent that are needed and to carry on such studies in the continuing, connected way that is required. Industrial companies may find it difficult to justify this type of effort for long periods, especially in areas which have little relation to their own future corporate plans and programs. Non-profit corporations are free from such limitations, and I think it is fair to conclude that this is a proper, but by no means exclusive, field for them.

The points I have just discussed apply also to short term studies of the same general nature, where more specific problems, not necessarily associated with any particular military program or system, are examined.

Basic and applied research is another area that should be examined. This field is also shared by military and non-military government agencies, by industry, and by all types of non-profit organizations. In industry much of this work is of course done in fields that are of direct corporate interest, but much is also conducted under government sponsorship. Among non-profit organizations, the universities and research foundations are the principal contributors. I think no one will question that this is appropriate. However, it is more difficult to make a clear case for the non-profit corporation. In the government, in industry and in our universities and research foundations there is a vast array of talent in this field, and it is hard to see a need for creating non-profit corporations for work in this area. However, in some cases it may be appropriate for non-profit corporations whose principal work is in other areas to do some research work. For example, the basic mission of such a corporation may

develop a unique competence in some particular research field. When this is the case, this competence should be utilized. Furthermore, it may be desirable for such corporations to engage in a limited amount of research as a means for attracting, developing and maintaining the competence needed for their principal mission. In general, however, I believe that research is not an appropriate primary field for them.

The situation with regard to development is similar to that in research. Although here I believe that the exceptions noted before apply more forcefully, and should be recognized. Further, there are some forms of non-profit corporation activity, such as System Engineering, where some preliminary related developmental work is essential and can often be done most efficiently as a part of the System Engineering. In general, however, I believe that development work belongs elsewhere, particularly in industry and the government.

### **Military Requirements**

Coming a bit closer to military programs, let us consider the area of military requirements. No one will question that this is a military responsibility. Ideally it should perhaps be done entirely by military organizations. Practically, this is not always feasible. In the explosive technology of today, and under existing governmental rules, it is next to impossible to provide in our military services all of the technical talent that is necessary to develop adequate requirements. So long as this situation continues the services will need some technical help from both industry and the non-profit organizations.

It is entirely appropriate that much of this support be secured from industry. However there is one important factor which, in some cases, favors the non-profit corporation. Military requirements must consider not only the need for a new weapon or a new system but also its relation to other existing or planned systems. New requirements lead to development, and manufacture by appropriate industrial companies. The companies whose systems in the field are affected, and those who are competing for the new system, have a proprietary motivation that might prevent complete objectivity in the formulation of requirements. The non-profit corporation does not have this disadvantage. Further, if assistance of this type is a regular continuing part of its service it will tend to develop a degree of proficiency and a familiarity with military problems, which are less likely to exist in organizations not continuously engaged in such work.

Next, I should like to discuss System Engineering—both the environmental kind, which is concerned with inter-system engineering, and the design of specific systems. The systems engineer must deal with operational systems, those being produced, and those that are not yet defined. He must consider, impartially, the whole spectrum of available technology. He must be objective, all the way from basic concepts to the broad specifications for individual systems. Here again the proprietary motivation in industry may interfere with objectivity. However—and I think this is very important—once a system has been defined to a degree that permits the military to contract for its development and manufacture, all of the advantages are on the side of industry.

There are several areas which I can group together and dispose of rather briefly. These are—development for production, manufacture, installation, and test. They belong to industry or, in some cases, to government agencies. They are not appropriate fields for the non-profit corporation.

Another area needs consideration—evaluation. When

military agencies lack the technical capability for adequate evaluation, the non-profit corporation is an appropriate source for support. The necessary objectivity might be attainable in industry, but as a rule industry itself might question an evaluation made by the contractor, or by his competitor.

Based on the foregoing I can summarize the case for the non-profit corporation in just a few sentences.

In general it should undertake only the things which, for any of the reasons I have discussed, are difficult to accomplish in government, industrial or other organizations. In special cases it may be appropriate because of unique capability or long experience in a given field, but it is primarily useful where complete objectivity is essential.

Some rules of conduct are necessary. Non-profit corporations should resist both internal and external pressures to expand into fields that properly belong to others. They must operate efficiently. They must be prepared to adjust to changes in work load. And they should be turned off when they are no longer needed.

If they operate under the general rules that I have discussed, I believe that they will not only be a source of valuable support to the government, but will help industry to do a better job. Nearly all of the industrial people I have talked to agree.

### **General Problems**

The general problems affecting our military effort I want to discuss are ancillary to technology. They are in many cases much less complex and perhaps they get less attention because of this. Yet they are of vital importance.

One of these problems is costing, including cost effectiveness. A good many monuments can be found along our road during the last 10 years to commemorate our mistakes in costing. Be realistic in your costing. Don't allow it to be biased by the eternal optimism of the inventor, or the competitive urge of the salesman. Your mistake in costing may well become the country's mistake in its defense planning.

Another problem is scheduling. All of us can name a good many military projects that are too late, or have been abandoned after heavy expenditures, because of an optimistic schedule. Be honest with yourselves and your customer. When in doubt, be a little bit pessimistic.

To achieve more reliability, make sure that outages, and maintenance costs won't ruin the usefulness of your product. At the least, make sure that your customer knows what to expect and prepares for it.

Another problem is operability. Don't design and produce gear that must be operated by PFC's with features that can only be handled by Ph.D.'s. The military world is full of gadgets that require a non-existent IQ in the operators.

In planning—especially long range planning, don't design an island paradise for the future without providing a means for transportation. Keep in mind, always, how you are going to get from here to there. Don't be too philosophic—keep in touch with reality.

The biggest non-profit technical organization of earth is the one operated by the USSR. They have done pretty well by specializing in a few areas at the expense of others and at the expense of the living standards of their people.

We cannot and do not want to conduct our defense efforts in that way, but we must do as well, or better, even in the special fields that are critical. We can do this with our kind of government and our kind of industrial organization, if we put our hearts and minds to the jobs.



— GOVERNMENT —

SEVERAL U.S. SPACE FEATS occurred last month. Discoverer XIII capsule was recovered from sea after being ejected from an Air Force satellite, marking the first time a capsule was successfully recovered from an orbiting vehicle, August 11. The following week Discoverer XIV capsule was retrieved in mid-air, August 19. Echo I, 100-foot diameter inflatable sphere, provided voice transmissions from Goldstone, Calif. to Holmdel, N.J. within hours after the NASA-launched vehicle was placed in orbit, August 12. The first transatlantic message was transmitted by bouncing signals off the sphere, August 23. X-15 rocket ship carried Air Force test pilot Major Robert M. White more than 24 miles skyward on man's highest flight, August 12. Air Force test pilot Captain Joseph Kittinger, after reaching an altitude of 103,300 feet in an open gondola balloon, free-fell 17 miles and then parachuted the remaining 2½ miles to earth, August 16.

NEW STRATEGIC TARGET PLANNING GROUP has been established for the purpose of pinpointing targets for retaliatory action in event of aggression, according to Defense Secretary Thomas S. Gates. Directed by General Thomas S. Power, head of the Strategic Air Command, the group will contain a staff of about 40 officers from all the services and liaison officers from the headquarters of the world-wide unified commands. The central planning group will be attached to the Joint Chiefs of Staff.

MILITARY COMMUNICATIONS SATELLITE capable of handling almost 3.5 million words per day will be launched soon. The Courier system, sponsored by the Advanced Research Projects Agency and developed by the U.S. Army Signal Corps, was supposed to be tested last month, but failure in one of the rocket boosters prevented the satellite from achieving its orbit. Courier will receive and record information from a ground station, simultaneously transmitting previously recorded information to the ground station.

ARMY PERSHING, designed to be a multi-range mobile weapon, was successfully test-fired from a mobile launcher in late July. Although the Pershing had been fired successfully in six previous tests, this latest test marks the first time the Army missile was fired from a mobile launcher. The missile was launched from the same vehicle that would carry it cross-country during a battle. The Martin Co. is the systems contractor for the solid propellant missile system.

REVISED SECURITY SPECIFICATIONS which should result in significant savings of both time and money for private contractors engaged in classified defense work have been approved by the Department of Defense. Contained in the newly revised edition of the Security Requirements Check List (Form 254), the specifications will be adopted throughout the military departments for use by defense contractors. The system will simplify contractor security problems by holding to a minimum the volume of information that requires protection. At the same time contractors will be furnished an improved classification check list. The check list is used to provide the contractor with a written notice of the security classification he is to apply to the various items he uses, develops and produces while performing his classified work.

NEED FOR OFFICER PERSONNEL CHANGES is being examined by a Defense committee composed of two retired officers from each of the military services. The eight-man committee was formed to study the career management pattern of officer personnel and to recommend revision of the Officer Personnel Act of 1947. It is believed that certain revisions in this act may be necessary in order to achieve uniformity among the military services in the career management pattern.

NEW ARMY ENGINEER OFFICE will expedite ICBM site construction, according to the Defense Department. The U. S. Army Corps of Engineers Ballistic Missile Construction Office in Los Angeles was established last month. The new office, which has an initial strength of 25 officers and 125 civilians, will streamline and strengthen intercontinental ballistic missile site construction. Brigadier General Alvin C. Welling, who has been Engineer Commissioner of the District of Columbia for the past three years, will direct work on the missile base construction sites as commander of the new office. Current ICBM site construction will cost about \$680 million and consists of construction of Atlas and Titan squadron sites at various bases.

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RADIO FREQUENCY COMPATIBILITY for military communications systems is being studied under a program established by the Defense Department. Aimed at providing policy guidance for all military agencies concerned with radio frequency control and use, the new program will place emphasis on finding ways to eliminate radio interference between systems. Both the research and development and the operational aspects of radio frequency interference control will be investigated. As a first step, the program calls for developing improved joint engineering standards clearly defining and limiting the interference characteristics of transmitting and receiving devices.

REVISED DIRECTORY on Government purchasing, specifications and sales has been issued by the Small Business Administration. The 116-page publication brings up to date changes in the products and services sought, purchasing office responsibility and sources of Government specifications made since publication of a similar directory by SBA in 1958. Available at the Government Printing Office, Washington 25, D. C., the publication is entitled "U. S. Government Purchasing, Specifications and Sales Directory."

TWO NAVY POLARIS MISSILES were successfully launched from a submerged submarine in the first two full scale tests of all elements of the fleet ballistic missile weapon system. The purpose of the tests was to launch a live missile from beneath the surface of the ocean and to guide its flight to a pre-selected impact area. The USS GEORGE WASHINGTON, the nation's first nuclear-powered submarine, was the vehicle from which the missiles were launched, July 20. Shortly after the launchings, the Navy announced the awarding of construction contracts for three additional Polaris subs. These contracts bring to 14 the number of Polaris subs in commission, under construction or scheduled for construction in specified yards.

AT AN NASA-INDUSTRY MEETING the National Aeronautics and Space Administration outlined its long range space program to some 1,300 representatives. The classified briefing, held July 28-29 in Washington, D. C., was the first such conference undertaken by NASA. Similar conferences may be held at NASA centers elsewhere, it is said.

NAVAL OBSERVATORY STATION near Flagstaff, Arizona will get a 60-inch reflector telescope that will be able to observe deep space probes and distant artificial satellites as well as determine the distances and motions of stars. The mirror system of the telescope will be made of quartz. This material was selected because of its optical stability.

NATIONAL BUREAU OF STANDARDS has increased the scope and reliability of its radio propagation prediction service so that military and commercial users are now able to utilize NBS forecasts more effectively. The large volume of ionospheric and solar data obtained during the International Geophysical Year has served to improve NBS's technique. The Bureau observes the changing state of the ionosphere and predicts, three months in advance, the maximum usable frequency for radio communications between any two points in the world.

CONTRACTS: ARMY: Hughes Aircraft Co., services and materials for the radar system of the Missile Monitor, \$4.6 million; Bendix Aviation Corp., Radio Div., development and installation of the new Army Criticon, a world-wide automatic teletypewriter network, \$4.2 million; Collins Radio Co., production of ground-to-air transceivers, \$1.3 million; General Dynamics Corp., Stromberg-Carlson Div., production of two engineering test models of single sideband tactical transistorized radio sets, \$1.1 million. NAVY: Radio Corporation of America, production of mobile radar sets for use at the Pacific Missile Range, \$6 million; Daystrom, Inc., continued classified research and development work on the Julie System, part of the anti-submarine warfare program, \$2 million; Telechrome Manufacturing Corp., production of complete telemetering systems for use in anti-aircraft missiles, \$1.6 million. AIR FORCE: Philco Corp., modernization of air communications stations world-wide for headquarters of Airways and Air Communications Service, \$4 million; Lear, Inc., production of vertical gyroscopes for aircraft use, \$2.6 million.

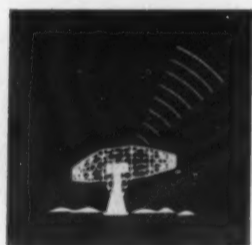
#### — INDUSTRY —

MISSILE INDUSTRY OFFICIALS discussed the status of the Government's long range missile programs at a meeting called by Defense Secretary Gates. Summoned were more than 45 top management men of companies that participate in missile programs and build sites for the weapons. The meeting was held July 29.

TROPO SCATTER SYSTEM capable of handling six 100 wpm teleprinter channels within a narrow bandwidth is under development at General Electric Co., Communications Products Dept. Present GE plans call for the ultra high frequency system to be used for Government needs such as civil defense and forward area tactical communications. The new system was described in a technical paper presented at the National Symposium on Global Communications last month in Washington, D. C. (Continued on page 33)



## radar problems?



Radar is America's front line of defense. And Hoffman has had experience in designing and producing various types of radar for military applications, including the APG-30A, APG-57 and SPG-34 fire control radar systems and the TPS-21 and TPS-26 combat surveillance radars. Techniques applied to these systems range from conventional pulse scanning radars to multiple lobe monopulse doppler systems. This background provides Hoffman with the knowledge and capability to help solve your radar problems.



RADAR



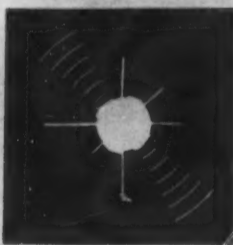
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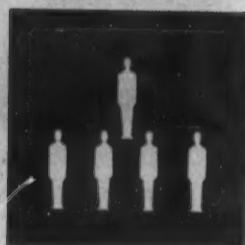
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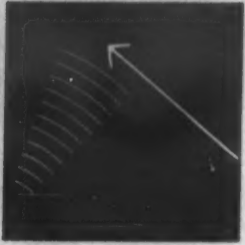
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## THE TRANSIT NAVIGATION SYSTEM

by M. A. SCHREIBER  
Applied Physics Laboratory  
The Johns Hopkins University



*In the early morning hours of April 13, 1960, APL staff members working on the Transit navigation system wait for a*

*signal from Cape Canaveral to mark the firing of the second stage of the Thor-Able-Star missile.*



IN LATE 1957 and early 1958, Drs. W. H. Guier and G. C. Weiffenbach of the Applied Physics Laboratory, The Johns Hopkins University (APL/JHU) made a study of the feasibility of tracking satellites, utilizing only the Doppler shift of radio signals transmitted from a satellite. These studies indicated that, when properly used, each segment of the received Doppler curve provides useful information about the satellite path, and that in order to gain the maximum information from the Doppler data, the data should be used in a direct calculation of the six orbit parameters rather than used to compute intermediate parameters such as the slant range and the time of closest approach. It was found that by utilizing all of the Doppler curve for determining the track of a satellite (orbit elements) a single Doppler curve, received during a single pass of the satellite by a single receiving station was sufficient to determine the satellite orbit to reasonable accuracy.

Table I indicates the results of a determination of the orbit of Sputnik I from a single Doppler curve. In determining this orbit the theoretical equation for the Doppler shift including ionosphere refraction effects was written as a function of the six orbit elements and two more parameters representing respectively a "Vernier correction" to the satellite's transmitter frequency and a parameterization of the electron density of the atmosphere. The eight parameters were then varied until the theoretically computed Doppler shift agreed with the experimental Doppler shift from the 20 mc transmitter of Sputnik I. For comparison, the values of the orbit elements determined by two British agencies from many sets of data including both interferometric and Doppler are given. It can be seen that accurate values were obtained.

If the inverse problem to satellite tracking is considered, namely determining the location of the receiving station, assuming a known satellite orbit (navigation) the ability to use a single Doppler curve becomes highly significant, since then a navigational fix can be obtained every time a satellite passes within range of the navigator. Furthermore, since navigation requires determining only two parameters (latitude and longitude) instead of the six orbital parameters of the satellite, a very large increase in the accuracy of the measurement can be expected.

Such an approach to navigation was suggested early in 1958 by Dr. F. T. McClure of APL/JHU. Shortly thereafter, initial studies on the expected accuracy of surface navigation utilizing the radio Doppler shift in a manner completely analogous to the above, indicated that this method could result in navigational accuracies of better than one-half mile.

The logical aftermath of the studies was the evolution of a navigational satellite system, beginning with the initial studies and continuing in sequence through an experimental and prototype phase which will culminate in an operational system. This operational system has been designated by the code name of Transit. It is aimed at achieving a passive, world wide, all-weather navigating system.

As noted above it is based on the fact that an analysis of the Doppler shift in radio-frequency signals transmitted by an earth satellite can be used to obtain orbital parameters of the satellite with a high degree of precision. Then, conversely, if the orbital parameters are known precisely, the observer's location can be determined accurately. Conceived at the Applied Physics Laboratory, The Johns Hopkins University, the program originally sponsored by the Advanced Research Projects

Agency, Department of Defense is being developed by APL/JHU for the Astronautics Group of the Bureau of Naval Weapons. Dr. R. B. Kershner of the Laboratory directs the technical program.

TABLE 1  
ORBITAL DATA  
SPUTNIK I—20 Mc, Oct. 21, 1957

| Estimated experimental error | $\pm 4$ cps           |                              |                   |
|------------------------------|-----------------------|------------------------------|-------------------|
| RMS fit to data              | $\pm 1.6$ cps         |                              |                   |
| Orbit Element                | Doppler Determination | Reference 1                  | Reference 2       |
| Period                       | 95 min. 38 sec.       | 95 min. 36 sec.              | 95 min. 34 sec.   |
| Eccentricity                 | 0.053                 | $0.053 \pm 0.001$            | $0.048 \pm 0.002$ |
| Inclination                  | $64^\circ 10'$        | $64^\circ 40' \pm 10'$       | $65^\circ$        |
| Argument of perigee          | $43^\circ 30'$        |                              |                   |
| Longitude of ascending node  | $289^\circ$           | $291^\circ 6' \pm 0.3^\circ$ |                   |

Reference 1—Staff of Mullard Radio Observatory, Cambridge, England

Reference 2—Staff of Royal Aircraft Establishment, Farnborough, England.

### Status

As of this date excellent progress has been made in the experimental program and demonstration of the feasibility of the system has been more than adequate. Three experimental satellites identified as Transit 1A, 1B and 2A respectively have been launched with the latter two successfully achieving orbital status. All launchings originated at the Atlantic Missile Range, Cape Canaveral, Florida. The Air Force supplied the "Thor-Able" type launching vehicle for the 1A attempt and the "Thor-Able-Star" type for the 1B and 2A. The former is a three-stage missile while the latter consists of two-stages with the second stage having restart capabilities utilized for the first time on the 1B launching.

Data from the short-lived flight of the Transit 1A navigational satellite (launched on September 17, 1959), furnished scientists with a complete test of the space vehicle's internal complex under all expected environmental conditions and a preliminary confirmation of the feasibility of the system. (Transit 1A reached the orbital altitude, but, owing to the failure of the third-stage engine of the launching vehicle to ignite, it did not go into orbit).

Transit 1B was launched into orbit around the earth, April 13, 1960. An excellent orbital determination was made a few hours after launch. Since its injection into orbit it has met several test objectives and notable progress has been made on others.

The pickaback satellite separation technique, subsequently used in the Transit 2A was successfully demonstrated, and de-spin of the satellite occurred. Telemetered data from the satellite indicate that the temperatures are within design limits and that the solar cell power supply is functioning as expected.

From the tracking data excellent orbits and the relative positions of several Transit receiving stations have been determined, the latter to within a few hundred feet of the surveyed positions.

The use of two frequencies in making corrections for the refraction effect of the ionosphere has proved effective. Investigation of the earth's gravitational field and the geodetic surface of the earth has been started.

All three orbital trajectories were intended to be circular with the 1A and 1B at an inclination of  $50^\circ$  and the 2A at  $67\frac{1}{2}^\circ$ . Orbital altitude was to be 400 nautical miles for the 1A and 500 nautical miles for the 1B and

2A. The 2A which was successfully orbited on June 22, 1960 will cover areas of the earth neglected by the 1B.

Riding pickaback on the Transit 2A was a 20-inch satellite designed to detect and analyze solar radiation and provide new information on the ionosphere. Bound to the Transit by a metal ring, the 40-pound unit was hurled from the Transit by a spring immediately after orbital injection from the second stage rocket. This satellite, which was developed by the Naval Research Laboratory, is programmed to travel in its own orbit as an independent satellite a short distance ahead of the Transit 2A.

The Transit tracking stations which receive the radio signals from Transit 1B and 2A are situated at the Howard County site of the Applied Physics Laboratory; at the University of Texas, in Austin, Texas; the University of Washington, at Seattle, Washington; at the New Mexico State University, Las Cruces, New Mexico; the U.S. Naval Air Station, Argentia, Newfoundland; the Royal Aircraft Establishment at Lasham, England, and San José dos Campos, Brazil.

The Doppler shift information is recorded in the ground receiving stations and special equipment reduces it to data suitable for the transmission on teletype to the APL computing center at Howard County, Maryland. The next station completes an identical recording and processing function until the total information is prepared and transmitted by all of the stations to the Univac 1103-A at the Applied Physics Laboratory.

With the stations and the computing center, APL scientists not only mark the parameters of the satellite but also predict its orbital paths for several days ahead. Once the satellite's future positions are calculated, they can be used by navigators as stable reference points with which to obtain an accurate navigational fix.

### Satellite Design

Each satellite launched to date has been an improved version of the preceding one. Since the fundamental considerations upon which the design are based have remained in force it has functionally and structurally remained common to all models. The improvements have resulted in part from the accumulation of new knowledge and information, such as improved packaging and circuit development and techniques, but mostly from evolution and development as planned from the experimental toward the operational units. It is gratifying to note verification of the integrity of the design from launching results observed to date.

The basic and unique design features are summarized in the following paragraphs and in most cases are applicable to all models. In general where notable differences occur they will be so commented upon. The accuracy of the system is dependent on many things and one of the most important of these is the choice and stability of the Doppler radio frequencies transmitted. Four frequencies are used which are derived from two ultra-stable crystal oscillator units designed to meet the following requirements:

1. Short term stability of 1 part in  $10^8$  for any 30 minute period during the life of the satellite.
2. Long term stability of 25 parts in  $10^6$  for three months.

(Flight results to date indicate even better stability than that specified above). The oscillator outputs each drive a frequency multiplier whose output in turn is fed to radio frequency amplifiers. The 54 and 108 mc outputs are derived from one oscillator and the 162 and 216 mc from the other. See Figure 1.

The use of six frequencies over a wide range neces-

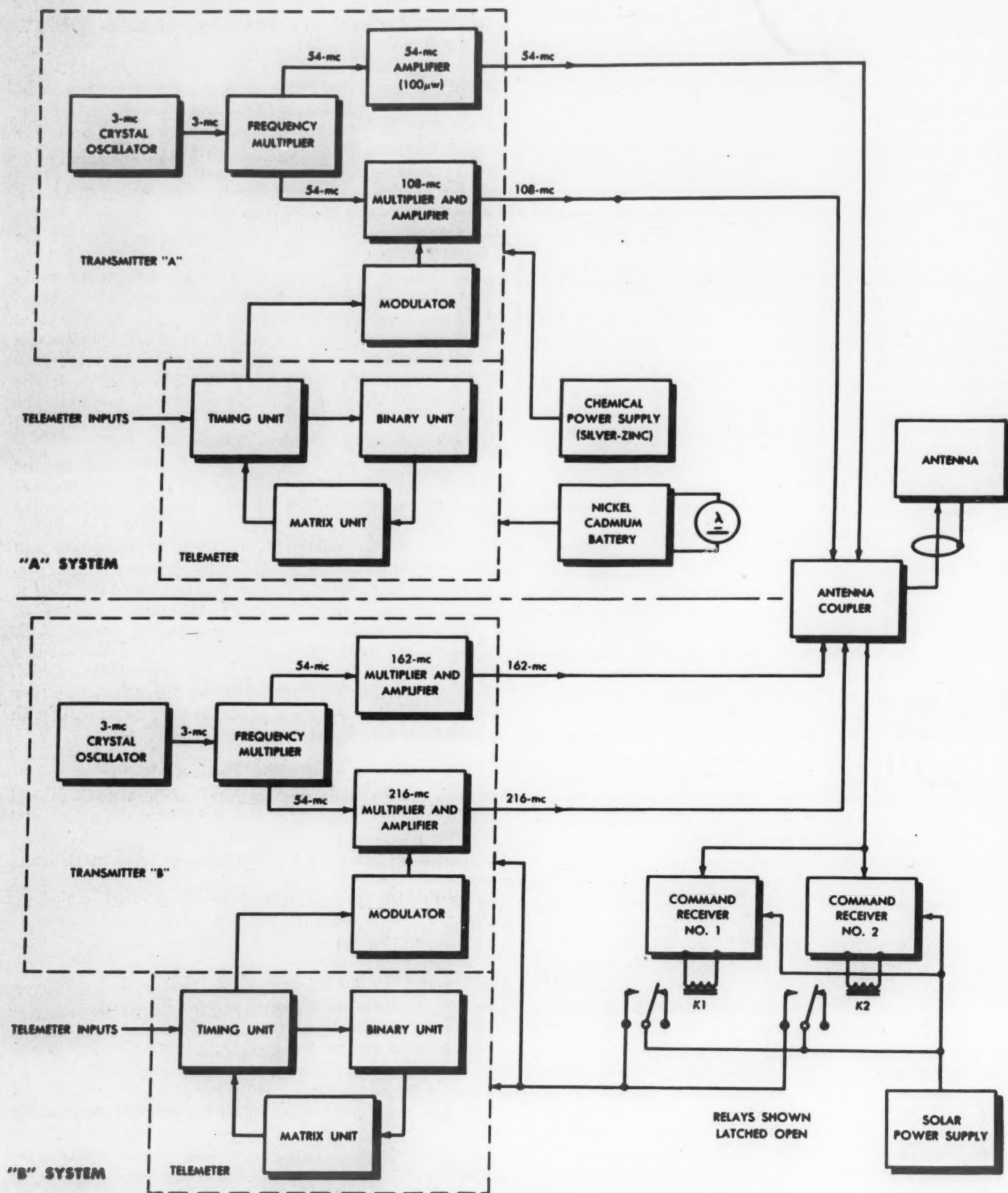


FIGURE 1.—BLOCK DIAGRAM OF TRANSIT 1A ELECTRONICS SYSTEM

sitated either the use of a broadband transmitting antenna or the complexity of separate antenna systems. Since the satellite is not stabilized with respect to the earth, the uncertainties of the attitude due to spin or space orientation required the radiation pattern to have a uniform field intensity in order to minimize signal strength fluctuations at the receiver. The specifications on which the payload antenna design was based called for peak-to-peak field intensity variations of not more than 10 db within the entire spherical coordinate system.

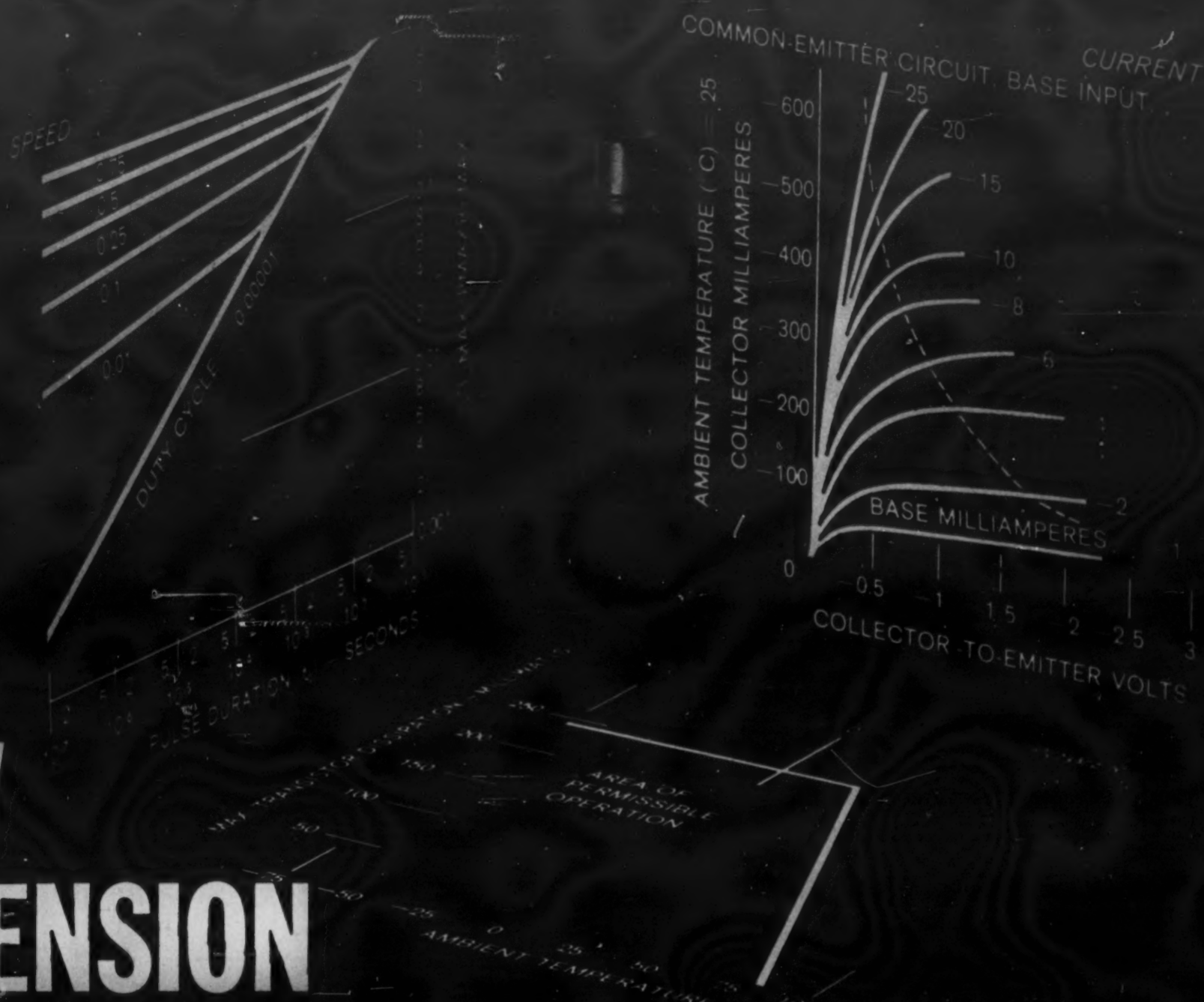
Another factor to be considered was the need for flush-mounted antennas to eliminate extended dipole elements or other radiating protrusions with their accompanying mechanical problems.

Considering the above, and taking into account the spherical shape of the satellite, an antenna was designed which resulted in a nearly uniform radiation pattern (isotropic radiator) over the entire spherical surface. This was achieved by utilizing the current and phase

(Continued on page 46)

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| COLLECTOR-TO-EMITTER VOLTAGE .....               | —30 max. volts |
| EMITTER-TO-BASE VOLTAGE .....                    | —1 max. volt   |
| COLLECTOR CURRENT .....                          | —500 max. ma   |
| EMITTER CURRENT .....                            | 500 max. ma    |
| <b>TRANSISTOR DISSIPATION:</b>                   |                |
| At an ambient temperature of 25°C                | 240 max. mw    |
| At an ambient temperature of 55°C                | 120 max. mw    |
| At an ambient temperature of 71°C                | 56 max. mw     |
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*General Pershing passing Peace Monument, Washington, D. C., September 17, 1919.*

## GENERAL JOHN J. PERSHING

*September 13, 1960 has been proclaimed by President Eisenhower "General of the Armies John J. Pershing Centennial Day." This is another of the many tributes paid a man who unselfishly devoted his life to the service of his country. Following graduation from the United States Military Academy July, 1886, General Pershing began a long and distinguished career in the Military. In 1919, by Act of Congress, he became General of the Armies, a grade first authorized for George Washington and since then held only by General Pershing. SIGNAL Magazine joins those who honor the memory of an outstanding American leader.*



*... Captain Pershing, Mindanao, Philippine Islands, 1903.*



*... General Pershing inspecting the troops, France, 1919.*



## eyes on the satellites

by

Anne Nelson Stommel

*The author is with the Publications Engineering Department, U. S. Army Signal Materiel Support Agency, Fort Monmouth, New Jersey.*

*Time exposure shows a rocket's vapor trail and the track of a balloon as it started on its course across the evening sky.*

"AT THE RETURN of the signal, it will be ex-act-ly four thir-ty five, a - m . . . dih dih dih dih dih . . . tock . . . tock . . . tock . . . tock . . ."

"Coming into the 'scope, now . . . reaching the center—NOW . . . leaving the 'scope, now."

You have just been introduced to some sounds that are very familiar to members of Moonwatch teams who volunteer their time to help establish the orbits and other characteristics of artificial earth satellites. The first phrase is the short-wave radio voice of Station WWV, broadcasting official time-signals of the National Bureau of Standards from Washington, D. C. The second is the voice of a Moonwatcher lucky enough to have a satellite pass through the field of his telescope.

Both sounds have been registered simultaneously on a tape recorder. Immediately after a productive session, when a satellite-crossing is actually observed, the tape is rerun. The "NOW," when the satellite went through the cross-hairs of the telescope, is matched to the "tock" of the time-signals from Station WWV, and the exact second is determined. The exact angle of the telescope-setting is already known, time and angle data are coupled, and a telegram or air-mail letter is sent off to Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, which coordinates the work of Moonwatchers throughout the world and constantly confirms or corrects its orbital predictions on the basis of their observations.

As can be gathered from the preceding paragraphs, much of the Moonwatchers' work depends upon technical skill for computing the probable time and angle of the

pass, setting up the short-wave radio and aligning the 'scopes. But much depends, also, upon many a person with the desire to contribute to our scientific and defense efforts and the willingness to devote countless hours in front of a telescope on the possibility that, sometime, it may be his mission to yell "NOW" to the microphone of the tape recorder.

Such a person must be willing, also, to adjust his time to that of the satellites. Having no light sources of their own, satellites can be seen only in the reflected light of the sun while it is still below the horizon—within an hour or so before sunrise or after sunset. In summer, those who man the telescopes must report to their observation post well before "four thir-ty five, a - m." In winter, the work can be quite chilling during early morning or evening hours with biting winds and temperatures below freezing.

A group of watchers is necessary at each observing session because a bank of telescopes is required to cover the general area the satellite is expected to pass. The telescopes are set up so that the field of each slightly overlaps that of the next one. Usually, the minimum number of telescopes is six and only one team member observes the pass. In the rare event that the satellite should appear in the overlapping zone of adjoining telescopes, two Moonwatchers may call out "NOW."

The first satellites to be launched were so small that the amount of light they reflected could not be seen by the unaided eye. Telescopes were needed to concentrate the light and make it visible. Even with larger satellites, how-

ever, telescopes are still required to pin-point the exact position of a satellite at any particular moment.

Electronic tracking devices have been developed to the point where human eyes are not so essential in establishing satellite orbits as they were in the early days of the Space Age. However, when Soviet Russia jumped the gun on the International Geophysical Year (IGY) by launching Sputnik I in October of 1957, Moonwatchers were really put to a test. Members of the Moonwatch team at Fort Monmouth, New Jersey (Red Bank 040-040-074—code numbers designate latitude and longitude) were on the job in daily, morning and evening shifts until the satellite was pinned down. They were among the first to spot it and to help establish its orbit.

Usually, Moonwatchers of any given station are not called upon daily or weekly, as satellites do not pass over the same point on the ground at the same time of day on such a regular basis. If they pass over New Jersey, for example, at 5:00 one morning, they may pass over Pennsylvania at that time the next morning. If they are in a stable orbit, geographically speaking, they may pass a given spot at 4:51 one morning; at 5:08, the next; then at 5:26, 5:44, 6:03—until the sky becomes so light that the satellite cannot be distinguished from its background. Other factors that keep Moonwatchers from observing the satellites are rain, clouds, fog and mist, or even a bright, full moon in the "wrong" spot.

But Moonwatchers are on the job whenever an observing session can be scheduled, even though dependable radar and tracking devices have come on the scene, because it is important to have a pool of trained personnel in the event that it becomes necessary to have eyes on the satellites. Such a necessity arose during the test-launching of the 100-foot balloons to be used in Project Echo, the National Aeronautics and Space Administration (NASA) experiment with inflatable, aluminum-coated, plastic spheres for use as long-range radio links. The balloons themselves are not instrumented and therefore could not radio data back to earth during their launching and inflation. NASA requested that observation by human eyes be used in conjunction with other tracking means during the test-launching from Wallops Island, Virginia, scheduled for the month of January this year. Among others, the Fort Monmouth Moonwatch team was alerted to participate. One of its members had sighted the initial, unannounced, test-launching the previous October 28, and established that the entire performance could be observed from their location.

Originally scheduled for Wednesday, January 13, the second launching was postponed at the last minute because of poor visibility along the entire Eastern Seaboard. Before the cancellation, however, members of the Moonwatch team had assembled at their observation post on the roof of the Hexagon, Headquarters of the U. S. Army Signal Research and Development Laboratory, despite the inclement weather and frigid temperature, on the possibility that they might be able to detect some aspects of the satellite's coursing through space. The same routine followed on Thursday night. Members of the team were assembled; cameras, radio equipment and a tape recorder were in operating condition; then, the launching was cancelled because all but one of the observing stations cooperating with NASA were closed in by mist and fog.

Finally, word came on Friday that the balloon would be rocketed into space on Saturday—"same time, same station"—if the skies were clear. The launching was scheduled for 5:35 p.m., but observers of the Moonwatch team began to assemble shortly after 4:00 to set up the cameras and other recording devices. On Saturday, the

launching went off as scheduled. Many photographs recorded the path of the rocket and balloon from the first appearance of the magnesium vapor trail in the southwest, as the rocket rose above the earth's shadow, to the disappearance of the 100-foot, aluminum-coated balloon over the ocean at about 5:45 p.m. Fort Monmouth Moonwatchers were on duty again for Shotput III, the third inflation-test launching from Wallops Island in February.

With test-launching out of the way, when these balloons are sent into orbit from Cape Canaveral, they can be seen with the unaided eye from nearly every part of the world. Everyone in the United States can have his or her eyes on the satellites, as formerly only a relatively few Moonwatchers had. Literally having one's eyes on the satellites is only a first step, however, to letting one's mind play upon the significance of their being up there in space.

Once in orbit, an instrumented space satellite becomes a self-contained and self-maintained laboratory equipped for numerous scientific investigations. If we could launch one a thousand miles into space, equipped with a 200-inch telescope like the one at Mt. Palomar, we could distinguish any objects that were a foot apart on earth. With television added, thousands of pictures could be transmitted back to earth each day. A start in this direction has been made with *Tiros I*, our weather satellite that photographs cloud cover and an unexpectedly clear view of the earth below.

The satellites that we already have in space transmit much data back to earth on the density of radiation and micrometeoritic dust, the earth's magnetic fields, weather, temperature and many other phenomena that affect our life on earth as well as man's potential well-being on flights into outer space.

### Solar Batteries

Fabricating the satellites has opened up new industries or buoyed up old ones. The electronics industry must provide, for example, "tape recorders" that store up information detected on one cycle around the earth, play it back instantaneously when interrogated by radio from earth and then erase themselves so the process can be started all over again on the next cycle. Since there are no repair men or trouble men in space, devices such as solar batteries must be used. Unlike chemical batteries, they do not need to be manually replaced or recharged at specific intervals.

The American watch-making industry was threatened with extinction by the importation of low-priced, foreign products until an increased emphasis on miniaturization caused by the small size and light weight desired for instrumentation compartments created a need for engineers and craftsmen who could think *small*. Watchmakers who were used to calculating stresses on miniature springs and gears, developing alloys that could withstand varying tensions for long periods of time or cutting almost microscopic threads on tiny screws are now helping to engineer instruments for the laboratory-satellites that we send into orbit.

To a Moonwatcher, the sound of the time-signals "dih dih dih dih . . . tock . . . tock . . . tock . . . tock . . ." will always conjure up visions of a group of dedicated people huddled about a bank of telescopes probing for a streak of light in the darkness above them. But anyone can figuratively put his eyes on the satellites and undreamed of vistas will open up to his mind's eye. For every phase of our civilization—science, politics, economics, education—is involved in our exploitation of the satellites that are already bringing untold benefits to our national defense and our free economy. — — — — —

# evaluation of the shielding effectiveness of BMEWS structures

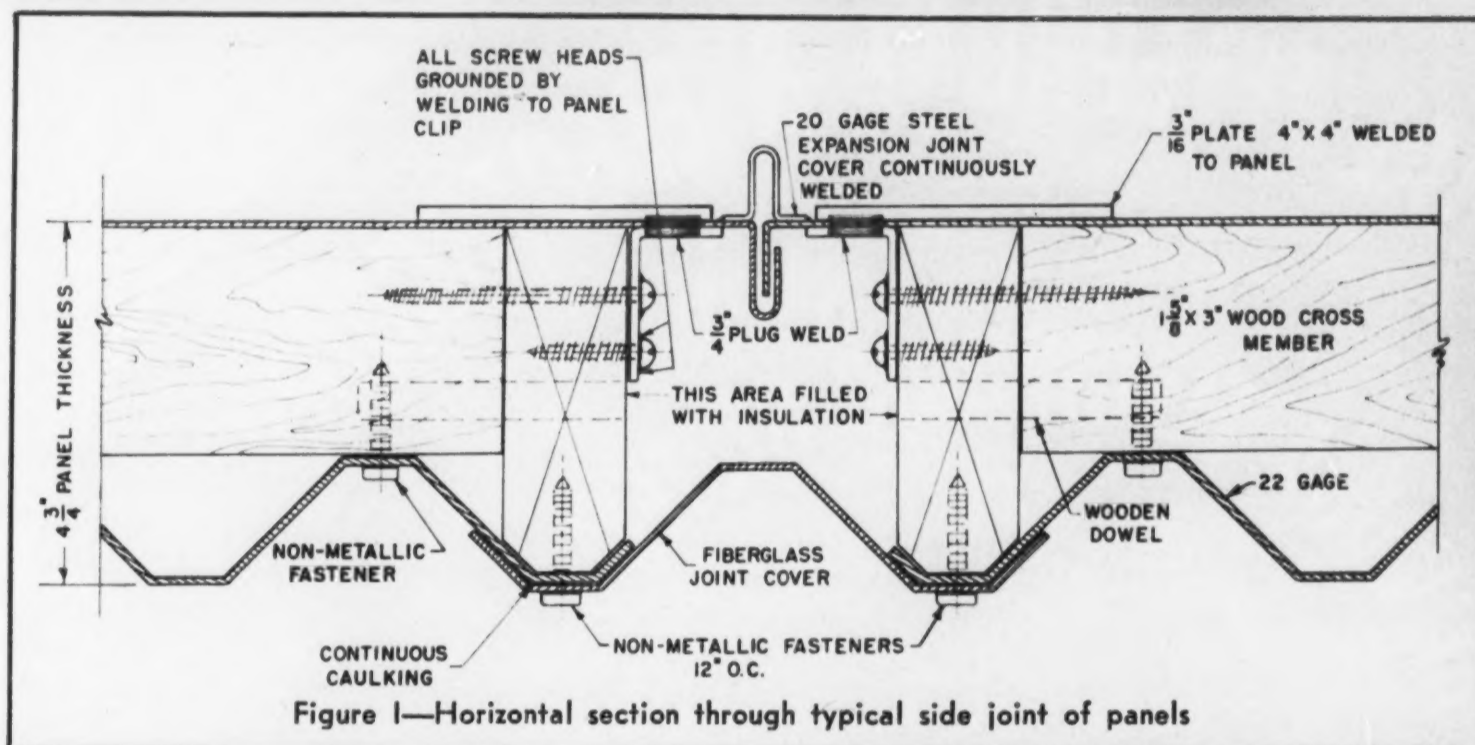


Figure 1—Horizontal section through typical side joint of panels

by J. J. O'Neill, Chief,  
Technical Operation Section,  
Electromagnetic Environment  
Division,  
Headquarters, U. S. Army  
Signal Research  
and Development Laboratory

**D**ETERMINE if a screen room more than a mile long ranging in height from 15 to 60 feet and in width from 20 to 400 feet will furnish 36-60 DB attenuation in the frequency range of 0.15 to 1000.0 megacycles." "Assure that various screened rooms internal to the large shielded structures provide the required degree of attenuation." "Accomplish this in the northern wastes of Greenland without delaying the operations of the building contractor."

## 3000 Mile Detection Range

This, in over-simplified terms, describes the task recently undertaken by U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey at the request of the Corps of Engineers, who are responsible for the design and erection of the first Ballistic Missile Early Warning System (BMEWS) in Thule, Greenland. This system which will be capable of detecting high-trajectory missiles of the "Jupiter" and "Atlas" type is a huge undertaking that will provide this country with a 3000 mile detection range and a minimum of 15 minutes warning in the event of an attack from over the North Pole. The system, insofar as the structures are concerned, consists of three Transmitter Buildings, the dimensions of which are 400 feet by 150 feet by 50 feet in height; four Scanner Buildings 150 feet by 80 feet by 60 feet high, in addition to a Cafeteria, Power Distribution Building, Electronic Maintenance shop and Heated Vehicle Stor-

age and Fire Station. These buildings, designed to withstand winds of 150 MPH, are laid out in a 6000 foot long semi-circle and connected by a passageway 15 feet high by 20 feet wide which is approximately 4800 feet long. This passageway provides RF radiation and weather protection for movement of operating personnel, carries utility lines from building to building and is large enough for vehicular traffic.

## Building Requirements

The shielding effectiveness required for the completed buildings varied depending upon their proximity to the antennae. The Transmitter and Scanner Buildings, for example, were required to have 60-70 DB attenuation as they were located in the areas of highest field intensity. The Power Distribution Building and the R.F. lock at the entrance to the passageway had a 40 DB requirement while the other buildings located at the extremity of the system had a lesser requirement. The purpose of the shielding was two-fold; to protect operating personnel from the extremely high R.F. radiated power which it has been estimated could kill a man at distances greater than a mile, and to assure interference free operation of the electronic equipment. Many types of material and processes to provide the required shielding were considered. It gradually evolved that with modifications a commonly used arctic type insulated panel 32" wide constructed of 18 gage galvanized steel

would be satisfactory as the shielding material. These panels were relatively economical (a very important consideration as approximately 1.25 million square feet of panels were required) and could be easily fabricated state-side. It was realized that 18 gage was heavier than actually required for shielding effectiveness, but it was selected for its structural strength. As the panels were to be welded together a galvanized material was considered most adaptable. Figure 1 illustrates the panels.

It will be noted that the interior "skin" is attached to the wooden frame of the panel with clips welded to the "skin" and screwed to the frame. In keeping with the requirements of Military Specification MIL-E-4957 entitled "Enclosure, Electromagnetic-Shielding. Demountable, Prefabricated, for Electronics Test Purposes" which was used as a guide, no segment of the clips or screws was closer than 2 inches to the exterior metal panel. The heads of all screws were welded to the clips to prevent loosening. The wall and roof interior panels were installed by means of clips welded to the "skin," which in turn were welded to the structural members. To assure the attainment of the shielding effectiveness goal, the vertical seams of the interior panels were covered by a 20 gage galvanized steel expansion type strip which was welded to each panel. Thus, continuity was assured up the wall across the roof and down the opposite wall. The

(Continued on page 28)

# HOW SEMO SIMPLIFIES



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(Continued from page 25)

horizontal seams between panels were covered with a flat steel strip which was also welded. A "low temperature" welding process consisting of a tungsten electrode, a silicon bronze filler metal and an argon shielding gas was used. A two-man team could weld approximately 60 linear feet per hour. The exterior panel material selected was 22 gage asphalt protected corrugated metal which was installed with non-metallic fasteners. A pre-formed fibre glass coverplate was used between panels and at the corners, ridges, eaves, and so on. The exterior facings of the panels were bonded together at each end seam of the wall and roof paneling with  $\frac{3}{4}$ " x 3" bond straps welded at 6 inch centers along the horizontal. Provisions to ground the exterior panels were incorporated by welding a 2" wide bond strap from each panel around the periphery of the building. At one corner a 4" strap was welded to the internal panel which in turn was connected to the grounding system of the site. Two layers of 16 mesh .018 inch diameter wire copper screen were used to provide shielding in all floors and certain roof areas of the buildings. The screen edges were pre-tinned with 60-40 solder for the 2" overlap which was required and were continuously soldered after installation with 90-10 alloy solder. The screen was protected by two layers of foam glass insulation over which the concrete was poured. To pre-tin the 1,000,000 square feet of screen required, the building contractor, Greenland Contractors Inc., designed a novel machine which, with a minimum of personnel, applied the flux, solder and coolant along each edge of approximately 3,500 linear feet of screen per day. The soldering, after installation, was accomplished by large gas-fired irons. The screen was bonded to the wall panels by means of continuous sheet metal horizontal strip welded to the panels and soldered to the screen. Space does not permit a description of the thorough bonding of structural members, base plates, and so forth, or of the wave guide filtering of the many penetrations for ventilators, stacks, and so forth.

When the shielding requirements and techniques had been firmly established for the system it was considered advisable that a prototype building be erected using the same materials, equipments and procedures that would be used at the site in Thule. This was accomplished at McGuire Air Force Base and was of consider-

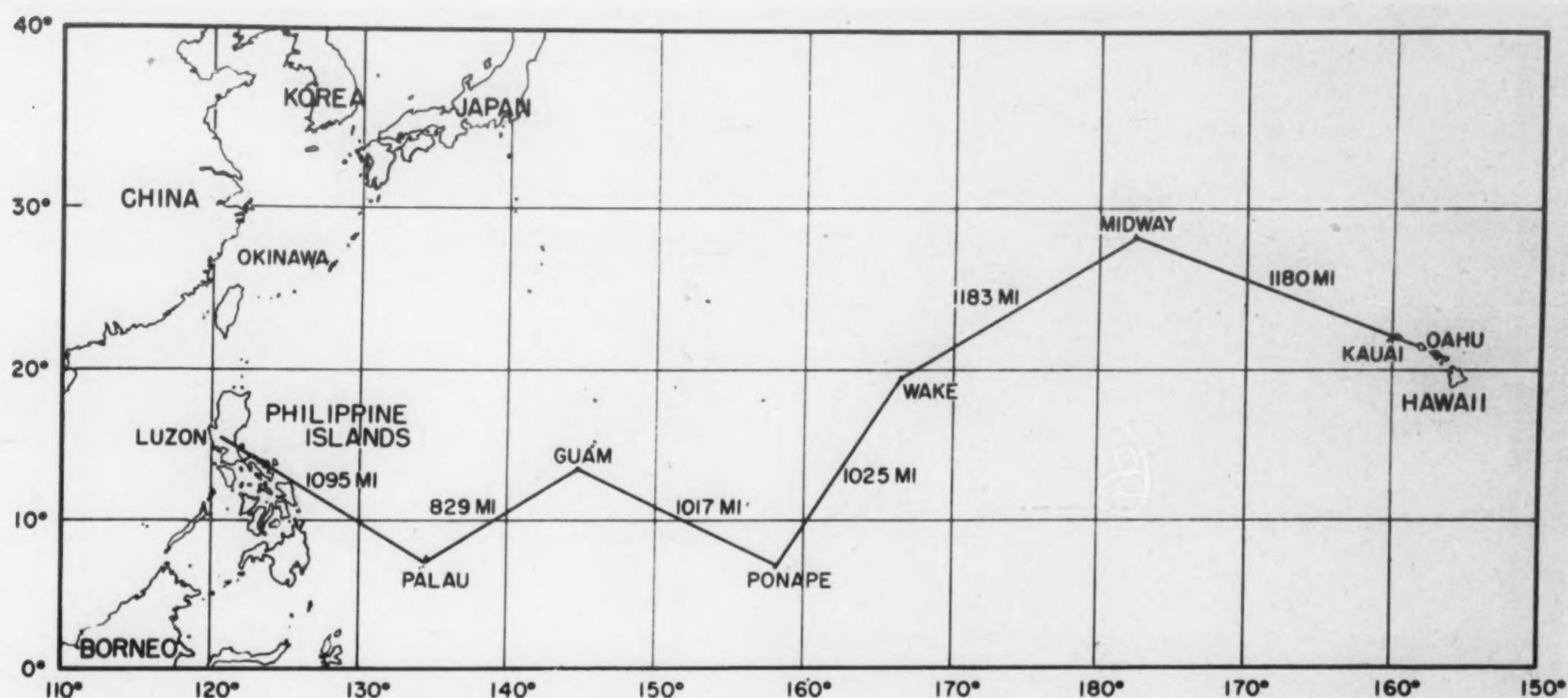
able assistance to the contractor, inspection personnel of the architect and USASRDL. Deliberate imperfections, the location of which were unknown to the USASRDL test team, and of the type which would be expected in the field were built into the building. In an effort to reduce the tremendous amount of welding a fairly large panel area was spot welded on 4"-6" centers rather than continuous seam welding, to determine if this procedure would furnish adequate shielding. Military Standard MIL-STD-285 entitled "Attenuation Measurement for Enclosures—Electromagnetic Shielding, for Electronic Test Purposes, Method of" was stipulated as the governing document for testing the shielding effectiveness of the structures. This specification is intended as a guide for the testing of relatively small screen rooms under comparatively ideal conditions. It was necessary therefore that the method outlined therein be modified so that the welded seams of the walls could be tested along their length (up to 60 feet) and that the roof panel seams be tested in a similar manner. Two methods were established to transport the noise sources and antennae along the seams; one utilizing a telescoping standard mounted on one of the many mobile interference reduction laboratories used by U. S. Army Signal R & D Lab., the other using a four-wheel wooden cart. Through the use of telephones, personnel outside the building coordinated their efforts with the engineer performing the attenuation measurements on the inside. Military Standard MIL-STD-285 requires measurement of attenuation of magnetic and electronic fields and plane waves. The equipments described in the standard as generators of the various types of signals were built in general accordance with the drawings with minor modifications to assure maximum output. The results of tests on the prototype building revealed that the seams that were continuously welded in a satisfactory manner furnished 60-80 DB attenuation over the required frequency range; spot welded seams did not furnish sufficient attenuation over the required frequency range, the built-in imperfections were easily located, and other flaws in the building due to human error could be easily located. Another finding was that a very strict, intelligent, visual inspection of the welding would practically assure the shielding effectiveness. This was highly important as it was apparent from the tests conducted that it would be impractical to test

each of the thousands of seams in the buildings at Thule.

Based on these results minor changes were made in the test set-up for ease of operation and the test team moved to Greenland. Here, as anticipated, conditions were entirely different. The building contractor's prime concern was to assure that all buildings and passageways would be "closed-in" before the severe winter storms and minor difficulties encountered during the prototype building tests were magnified a hundred-fold. In keeping with the requirement that the contractor's operations not be delayed, to assure a minimum of corrections after the buildings had been "closed-in" and as the buildings had not progressed to a point where any testing would be meaningful, it was decided that a strict visual inspection along the length of each seam would be conducted. This inspection was complemented by X-rays of welds which appeared somewhat suspicious. The contractor was welding six panels together, prior to assembly on the building. As this welding was done in a jig in a horizontal plane, an excellent job generally resulted except during periods of high winds when "snuff-outs" occurred. However, when these panels were moved into position on the building alignment difficulties were frequently encountered and it was necessary that these intersecting seams receive the closest scrutiny. Another problem area was the installation of the screen. The screen with its pre-tinned edges was rolled into place and then soldered together. This was a tedious task and in the beginning many stretches of "cold solder" joints were detected in addition to voids. However, the technique rapidly improved and although it remained a very time-consuming task the workmanship was satisfactory. Damage to the screen after installation and prior to laying of the foam glass insulation was another problem area. Dropped tools and general pedestrian traffic punctured holes in the screen and it was necessary that these be patched. Covering these areas with hard board was later instituted, which corrected this problem.

In testing a screen room or shielded building it is generally necessary that the shielding envelope be complete. This was not possible in testing the BMEWS structures as it was necessary that areas be left open either for placement of equipment or because all necessary material was not always available when required due to

(Continued on page 48, col. 3)



## PACIFIC SCATTER COMMUNICATIONS SYSTEM

by ESTERLY C. PAGE

President, Page Communications Engineers Inc.  
A Subsidiary of Northrop Corporation

A NEW 6,500-MILE trans-Pacific communications system, utilizing the latest ionosscatter and troposcatter propagation techniques, today provides the Department of Defense with the *only* continuously reliable message traffic service between key points from Hawaii to the Philippines.

Managed by the U. S. Army Signal Corps as part of the world-wide Strategic Army Communications Network, the Pacific Scatter Communication System furnishes the first wholly dependable and trouble-free communications between America and powder kegs of the Far East. Before the development of this system, communications between this country and the Pacific area often had been impossible.

Operating on a 24-hour basis, the system provides 16 teleprinter circuits and one voice order wire—on either of two frequency bands, a regular or alternate band—between adjacent stations in the system. Teleprinter messages are presently handled over these circuits and channels at 60 words per minute.

Largest of its kind in the world, the system presently extends from Hawaii via Midway, Wake, Ponape, Guam and Palau to Luzon in the

Philippines. Within months it will be expanded to include Okinawa, and subsequently will extend to Taiwan and other Asiatic terminals.

All but one link (within Hawaii) utilizes ionosscatter propagation for communication between adjacent stations of the system. This technique assures extremely stable communications under conditions which ordinarily would disrupt conventional long-range radio communication.

This technique utilizes very-high-frequency radio waves, which are transmitted upward at such an angle that they are returned from the ionosphere, a distinct layer of the earth's atmosphere. These waves return to earth as scattered fragments of the original radio waves, but can be detected with highly sensitive receivers at each station. Developed within the last decade, the ionosscatter technique permits reliable communication between a transmitter and receiver 600 to 1200 miles apart.

A major advantage of the ionosscatter technique is its application outside the crowded high-frequency portion of the spectrum, minimizing interference from other stations and systems. Also, conventional long-range radio communication requires

frequent changes in operating frequencies to meet varying atmospheric conditions during every day and night. The ionosscatter technique uses a fixed frequency for continuous passage of high-speed message traffic over the system. This allows maximum passage of traffic, simpler operation and maintenance, and eliminates using many radio frequencies of the spectrum.

One link, between Oahu and Kauai in Hawaii, utilizes troposcatter propagation. Operating at about 800 megacycles, this is an ultra-high-frequency version of the ionosscatter technique, where radio signals are bounced off the troposphere high above the earth.

Reliability of the system—which approaches within a fraction of 100%—is achieved through a combination of advanced engineering system design, equipment especially developed for ionosscatter or troposcatter propagation, and standardized operation and maintenance procedures.

To provide almost complete assurance against possible failure, critical equipment at every station is in duplicate; and the stand-by equipment is

(Continued on page 48, col. 2)

TO THE ENDS OF THE EARTH...

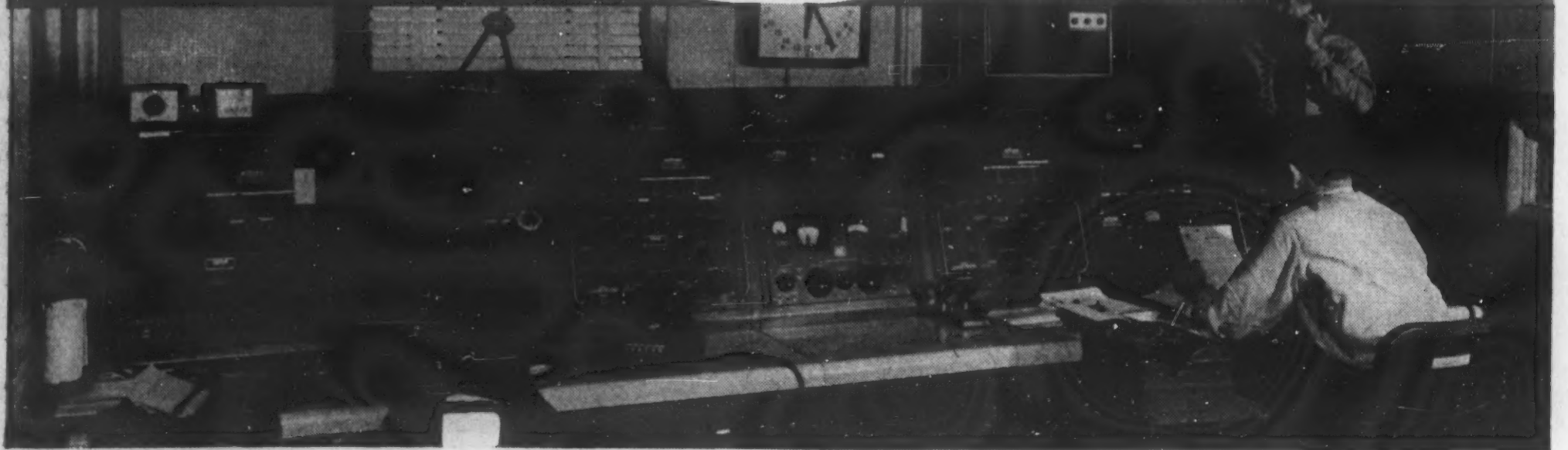
... communications  
from ground to aircraft is achieved  
with Wilcox single sideband equipment.

The North American Air Defense Command  
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communications with the Commander-in-Chief, NORAD,  
through the NORAD Single Sideband Air/Ground Station,  
operated by the 47th Communications Squadron at Peterson  
Field, Colorado Springs, Colorado. It also provides a vital  
world-wide communications link for ADC, MATS, SAC and others  
engaged in the defense of our country.

The majority of the equipment of this  
station is supplied by Wilcox. It is  
indicative of Wilcox's ability to de-  
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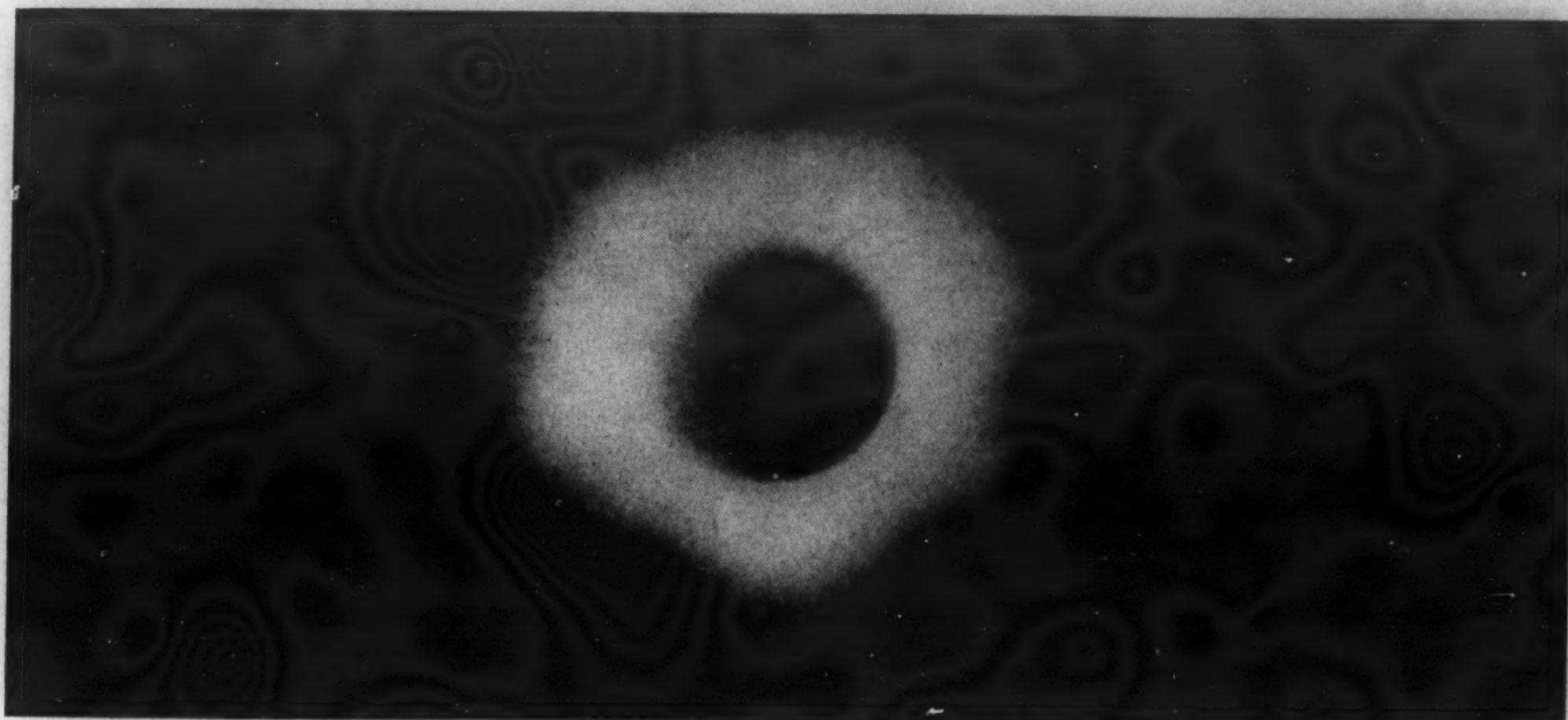
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# What's Over The Sun ?

by Dr. Edith J. Tebo, Associate Research Scientist, Exploratory Research Division 'S', Headquarters, U. S. Army Signal Research and Development Laboratory, Ft. Monmouth, N. J.



THE CURRENT burgeoning of astronomical interest and research is commonly ascribed to today's missile and space projects. While the resurgent interest in astronomy from those outside this field may indeed be due to "space science," developments within the field in the last 10 to 15 years have imparted an enthusiasm to astronomical research in areas basically different from space technology. Astronomers at last seem to be reaching an understanding of the formation and evolutionary processes of the universe as a whole, and of fundamental notions about form, order, and change. This search is for something greater than technological achievement, which is the end result of many of the current activities in the name of "space science." This search is for a real understanding of the *nature* of things. Astronomers have already begun to understand the processes of star formation, the subsequent history of stars as they live out their fuel supply, the formation of the chemical elements and the connected history of galaxies made up of evolving stars.

Although astronomy is the oldest of the physical sciences and in truth the only one included in the liberal arts curriculum in the middle ages, emphasis shifted to the practical aspects for the sake of navigational needs. Although there was not much distinction between an astronomer and a physicist in the days of Galileo Galilei and Johannes Kepler, the practical problems (navigation, pre-

paration of catalogs of stellar positions, etc.) absorbed so much time and energy that many astronomers ceased to be physicists. Such a division between physics and astronomy has now largely disappeared in most fields within astronomy. Astronomy is now expanding in several different areas and some of our astronomers are no longer so "pure." Today we have more "applied" astronomical research albeit our "purest" astronomers decry this fact as well as the industrial raids on this country's rather meager supply of astronomers. However, we do not yet have the subject of an advertisement in the February issue of *Physics Today*: "Qualified engineers in astrophysics."

But we need them all: the basic and the not-so-basic, the "impractical" and the practical. Of course one could go on with other antitheses: e.g., pure science versus technology, reports versus hardware, etc. However, there is often no single line between the two areas and within astronomy we have many new hybrid areas.

## Need for Basic Research

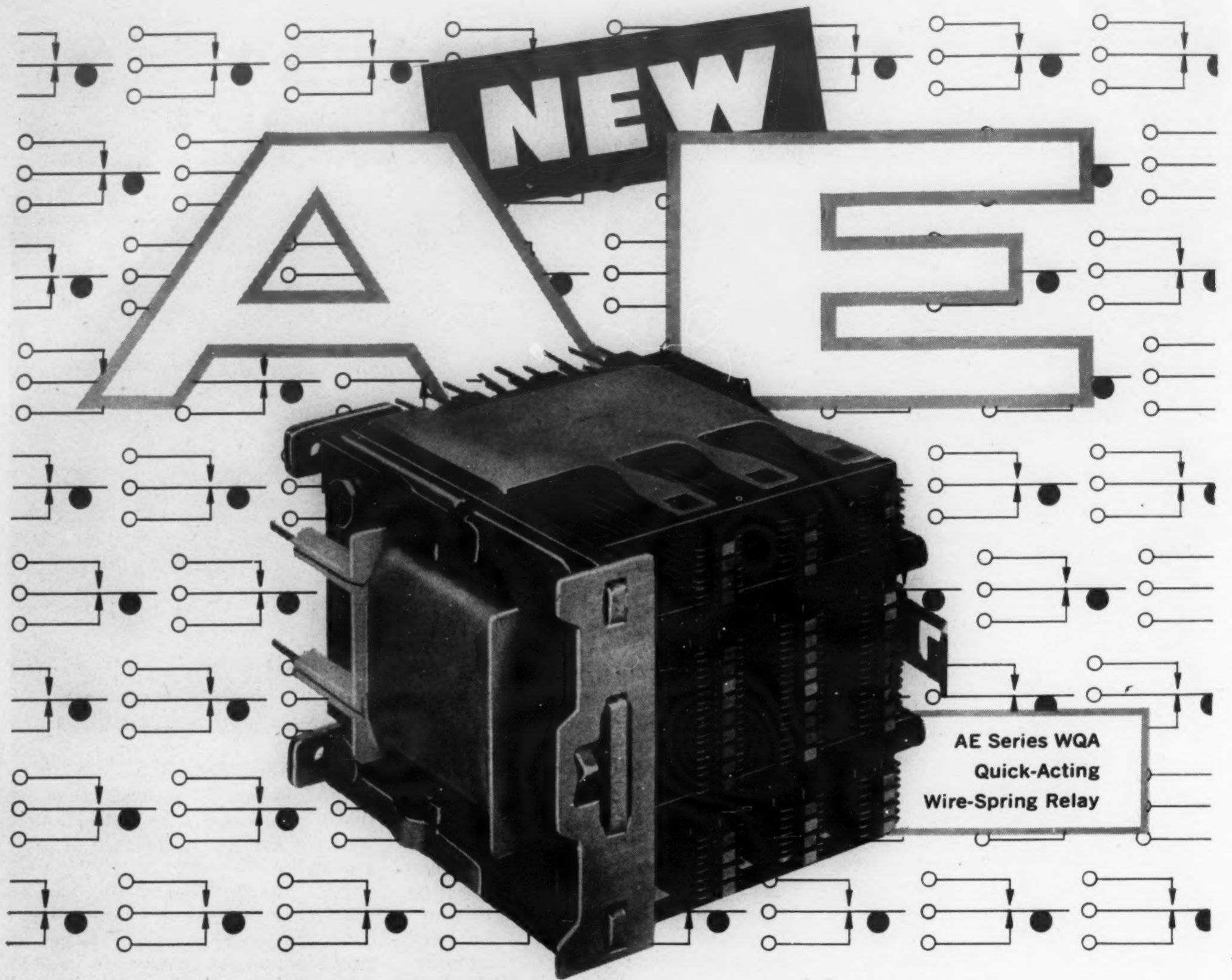
That we must maintain our technological competence and superiority has become increasingly clear within the last 15 years. Although this has been decried by some as strictly a military matter, improving the state of science is in fact a very common cause. Our freedom, with its duties, is at stake. I should much prefer that my daughters be able to choose

whether they will study Russian or not. However, we must all recognize that to enjoy the fruits of technology we must first dig in the field of basic research.

And what have these various species of astronomers been doing? Since the more "practical" facets are probably better known to SIGNAL readers, let us look at the "purer" facets and the borderline areas. There may be those who want to know what practical applications these areas might have. Who knows? But who could have predicted the uses of studying either the entry problem for meteors or the nuclear reactions occurring when a star converts hydrogen into helium?

Although we hear much talk these days of greater specialization, there are at the same time many areas which require much correlation and synthesis among various disciplines, such as the study of cosmic rays, or of solar-terrestrial relations.

Some of these new overlapping fields (e.g., astro-geo-physics and "space science") have sprung up because of either a difference in motivation or a difficulty in establishing where "astro" begins and "geo" ends. Since astronomers have had to look at the sky through the earth's atmosphere, they've had to study the atmosphere in order to know what kind of corrections to make (e.g., extinction, refraction). But there are those who study stellar scintillations in the radio region not to eliminate  
(Continued on page 38)



## TO THE ENGINEER who wants to transfer 51 circuits simultaneously

If you need simultaneous transfer of a large number of circuits without fail, take a look at AE's new WQA relay. It will do the work of four or more heavy-duty, general-purpose relays each with maximum spring pile-ups, and sustain 50 million or more operations without readjustment.

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chronized "break-before-make" on all circuits. Contact capacities on WQA relays can be custom-tailored to your needs, with either one, two or three levels of contact assemblies available, each with a capacity of 17 Form C combinations. Other Forms available.

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# ***AUTOMATIC ELECTRIC***

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*Signalgram (Continued from page 16)*

AEROSPACE CORP. is the new non-profit organization recently formed to serve the Air Force in the scientific and technical planning and management of missile-space programs. Under contract from the Air Force, Aerospace will do certain work previously performed by Space Technology Laboratories, Inc. Aerospace will seek to accelerate programs in such areas as advanced re-entry vehicles, satellite communications systems and manned military space systems. To conduct its operation, Aerospace will utilize extensive laboratory and other facilities at the El Segundo (Calif.) Research and Development Center which the Air Force is purchasing from STL.

AMERICAN TELEPHONE & TELEGRAPH CO. will build a transatlantic telephone cable which will provide greater range and circuit capacity than is now possible with the two AT&T oceanic cables now in operation. Costing about \$35 million, the single cable system will provide the equivalent of 128 voice circuits. The new cable, which will go to Great Britain, will be the first telephone link directly across the Atlantic from the United States. The two other cable systems are in operation via Newfoundland, one to Scotland and the other to France. Scheduled to be built in 1963, the new system will be jointly owned by AT&T and the British Post Office, which is responsible for telephone service in Great Britain.

TEXAS INSTRUMENTS INCORPORATED is responsible for an advanced new radar said to increase air terminal safety. A total of 34 airports will get the airport surveillance radars during the next year and a half. With this radar, air traffic controllers can pick out individual airplanes on the radarscope. Controllers will have a choice of several types of improved presentation on the 16-inch, TV-like picture tubes. They may look at fixed and moving objects or moving objects only.

ELECTRONIC COMMUNICATIONS, INC. of St. Petersburg, Florida, received a \$250,000 contract from Rome Air Development Center for the development of a secured communications equipment for use in the USAF Global Communications System. Design requirements for this equipment have been dictated by the growing need for improving basic communications techniques and a requirement to decrease the per-channel mile cost.

LABORATORY FOR ELECTRONICS, INC. of Boston, has been awarded a contract for production of four AN/TPN-12 Tactical Ground Control Approach Radars for the Royal Swedish Air Force. The radars will be installed at airfields used jointly by the Royal Air Force and Swedish commercial airlines. The TPN-12, a light-weight, portable air traffic control system, operates in Surveillance or Precision Approach modes.

RADIO CORPORATION OF AMERICA has entered the electroluminescent lighting field and is manufacturing light-emitting panels for consumer, industrial and military use. The panels give off a soft glow of light and are designed for use in decorative lighting, illuminating dials, control panels, highway signs, signals and safety devices. They will be manufactured under the trade name of "Panelray."

SYLVANIA ELECTRIC PRODUCTS INC., a subsidiary of General Telephone & Electronics Corp., will produce electronic defense systems for the Air Force B-58 Hustler bombers. The work will be done under a \$20 million contract from Convair Division of General Dynamics Corp., prime contractor on the Hustler project. About \$5 million of the total will be used for production and engineering of advanced traveling wave tubes, "which form the heart of the Hustler countermeasures system." The contract brings to approximately \$145 million the total awards to Sylvania for development and production work on the systems over the past six years.

ACF INDUSTRIES, INC. has developed a pictorial navigation display unit designed especially for commercial and business aircraft. The unit utilizes a moving device, representing an aircraft, which moves freely under a transparent display map to indicate an aircraft's position above the ground. The position of the device on the mylar map is determined by bearing and distance information which the ground stations provide the aircraft equipment. This constantly changing data positions the device under the map in synchronization with the ground track of the aircraft.

SPACE CAPSULE RECOVERY SYSTEM that would use helicopter-like rotary wings to slow and glide a space capsule back to earth will be studied by Kaman Aircraft Corp. under an Air Force contract. The Connecticut firm will examine the feasibility of the rotochute system in which rotor-like blades are extended from an ejected space capsule and are set in motion by aerodynamic forces. This action slows down the re-entry and also sets the course for a predetermined glide pattern for the space capsule. In the initial phase of the program, Kaman will release 196-pound blades from subsonic aircraft. The possibility of using larger blades for the recovery of heavier payloads at supersonic speeds will be investigated later. The basic system currently used for recovery of space capsules contains parachutes and retro-rockets. In this system, the retro-rocket slows down the moving vehicle and parachutes are employed for the descent of the vehicle.

*(Continued on page 36)*

CREATIVE ELECTRONICS FOR DEFENSE

## STRANGE "FISH" UNDER THE POLAR ICE!

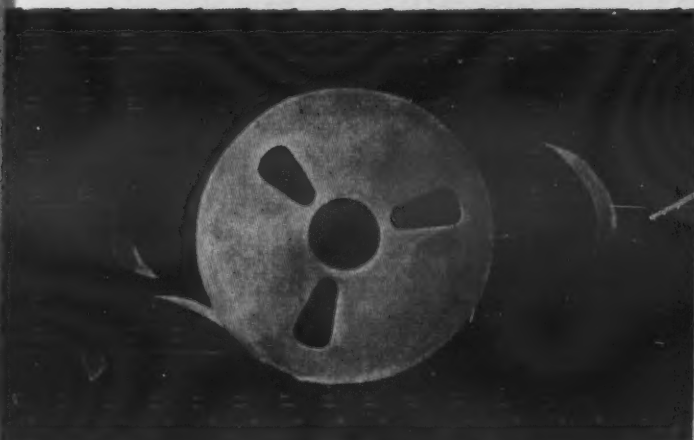
### Revolutionary RCA Magnetic Video Tape Recorder to Speed Navigation Training of Submariners

Aboard the nuclear submarine *Sea Dragon*, the first undersea magnetic video tape recorder will record and store data on under-the-ice characteristics from externally installed TV cameras. Upon return to base the recorded information will be displayed for the benefit of undersea service trainees, greatly increasing their understanding of hazardous polar navigation techniques. The recorder, a joint U.S. Navy-RCA effort,

is a marvel of compact design (dimensions: 20"x 20"x 100"). It nestles securely in the limited confines of a torpedo rack, yet represents a 60 per cent space reduction over existing commercial video tape equipment. Designed to the curvature of the torpedo rack it will fit through the opening of a 24-inch hatch. Though small in size, the 4 megacycle recording it produces is fully compatible with its commercial counterpart!

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**Coming for business**—a "video file system" capable of storing an entire encyclopedia on one 12½ inch reel, contents of which would equal 20 billion bits of information!



**Coming for entertainment**—the ultimate in color TV and video fidelity . . . via extremely portable recorders that will provide a panoramic view of world events virtually as they happen!



**Coming for science**—completely unattended recorders, robot-rocketed to the moon, will, on command, provide a detailed "picture" of space, free of the earth's atmosphere!

Other exclusive RCA recorder developments now contributing to national security include—the "Tiros" satellite recorder, designed for weather observation in outer space; a radar recording system to take the first pictures of a nose cone re-entry vehicle; a unique tape cartridge adaptable to *any* size recorder. For information on opportunities in creative engineering write: G. R. Gordon, Defense Electronic Products, Radio Corporation of America, Camden, N. J.



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— GENERAL —

FIVE MODELS OF THE GRUMMAN MOHAWK, the U. S. Army's first medium weight observation aircraft (all weather), began official trial flights June 22. All five will be put through their paces in order to test the basic airplane and its all-weather photography and radar equipment. Mohawk is designed to "live in the field" with tactical troops, take off from small unprepared fields and provide all-weather tactical observation for field forces.

MAJOR ASPECTS OF ENERGY CONVERSION TECHNOLOGY and its application to advanced power systems for space vehicles are scheduled for coverage at the American Rocket Society's Space Power Systems Conference, Sept. 27-30, Miramar Hotel, Santa Monica, Calif.

INDUSTRY SEMINAR for administrators of scientific and engineering functions will discuss methods of achieving "scientific creativity" in large organizations. The seminar will be held at Minnowbrook Conference Center at Syracuse University, September 11-17.

AN OUTER SPACE COMMUNICATIONS SYSTEM that uses solar radiation as the means of transmission in place of conventional radio waves is now under development at Electro-Optical Systems, Inc. Sponsored by the Air Force's Wright Air Development Division, this solar communications system (SOCOM) utilizes the sun's rays to provide optical communications over interplanetary distances. Some advantages of SOCOM over conventional radio frequency systems include lower weight and power requirements, more secure communications due to narrow beam width and high signal-to-noise ratio in space, according to Electro-Optical Systems. In operation, SOCOM collects the sun's rays in a mirror antenna system, funnels the rays through a modulator for coding and transmits them via a second mirror system to the receiving unit. The receiving unit also uses a mirror antenna system for collecting the signal. This signal, which is concentrated on a detector at the focus of the receiving unit's antenna, is then fed into a signal processing unit and finally read out.

AT THE SECOND STRATEGY SEMINAR for reserve and National Guard officers, the challenges to U. S. leadership posed by the threat of communism were outlined and measures to counter that threat were discussed. Approximately 200 officers of the reserve components of the Army, Navy, Marine Corps and Air Force attended the thirteen-day seminar held last July in Washington, D. C. Participants were selected from those officers who are active in public affairs and can, through their position in civilian life, help alert the U. S. public to the dangers inherent in the present international situation.

THE INTERNATIONAL ATOMIC ENERGY AGENCY will soon convene a meeting (September 6-17) of the world's nuclear specialists in Copenhagen, Denmark to discuss potential peacetime applications of radioisotopes in industry and areas of public benefit. The U.S. Government has chosen David Chleck, research chemist at Tracerlab, Waltham, Mass., to take part in the conference.

TV TRANSMISSION between France and Algeria began July 14 when the television networks were connected by using 4.000 mc scatter links between the Pyrenees and Algiers. The experimental transmission system requires the use of only one repeater station to cover the nearly 700 kilometer distance. Equipment for the system was developed and manufactured by Telecommunications Radioelectriques et Telephoniques.

SOLAR POWERED RADIO TRANSCEIVERS were used to exchange messages between the Seventh Army Headquarters in California and the U. S. Army Signal Research and Development Laboratories at Fort Monmouth, N. J. While solar cells have previously been used as a power source for radio and television transmission in satellite tests, this marks the first time that such power has been used for transcontinental communications. Weighing 24½ pounds each, the transistorized transmitter-receiver units were developed by Hallicrafters, Inc. of Chicago. These units soon will be available for civilian use by ham radio operators, according to Hallicrafters.

CALENDAR OF EVENTS

SEPTEMBER 14-15: Fourth Annual Joint Military-Industrial Electronic Test Equipment Symposium, sponsored jointly by the Office of the Director of Defense Research and Engineering and the U. S. Army Signal Corps, Chicago, Illinois.

SEPTEMBER 19-22: Industrial Film and Audio Visual Exposition, New York, New York.

SEPTEMBER 19-22: National Symposium on Space Electronics and Telemetry, sponsored by Institute of Radio Engineers, Washington, D. C.

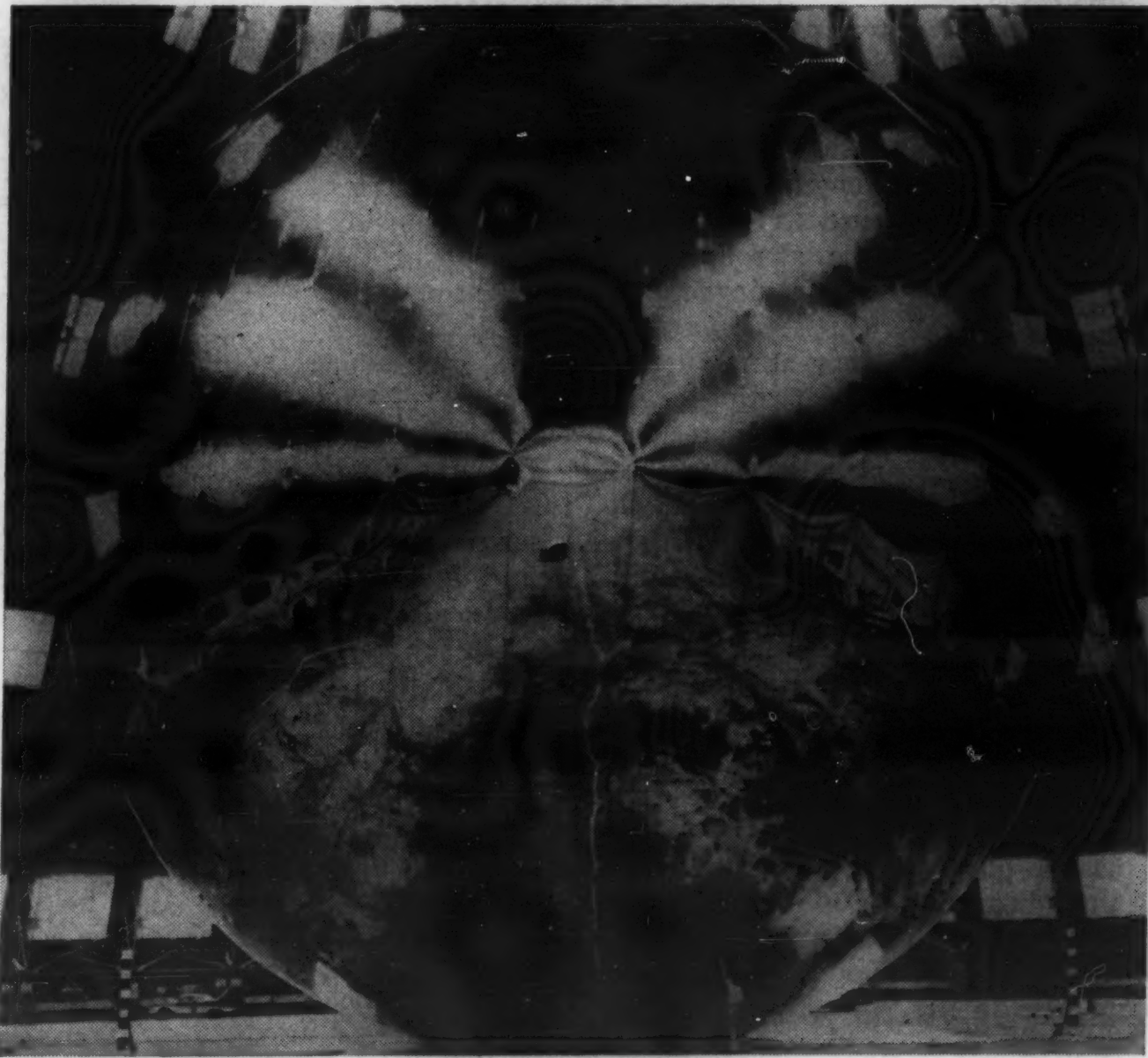
OCTOBER 10-12: National Electronics Conference, Chicago, Illinois.

OCTOBER 12-14: Quartermaster Association Convention, Washington, D.C.

# PROJECT ECHO

's aluminum-coated sphere (pictured below) was rocketed into orbit at 5:40 A.M., EDT on August 12. At 7:38 A.M., an unmodulated signal from the Jet Propulsion Laboratory, Goldstone, California, gave the first indication of a successful launch when the signal was picked up by the Bell Telephone Laboratories' installation at Holmdel, N. J. Three minutes later, President Eisenhower's voice was transmitted from Goldstone to Holmdel via Echo. Thus, did the world take one more step in its efforts to achieve transoceanic communications by means of Earth satellites. In December 1958, President Eisenhower's voice was relayed through space for the first time by the Atlas satellite which carried the President's Christmas message to all the world.

The Project Echo experiment began when a sleek Delta rocket rose from the launching pad at Cape Canaveral and streaked into the morning sky. The rocket reached orbital altitude and released its payload, a 26½ inch diameter magnesium container. Two minutes after orbit, the container split open by an explosive charge and the sphere inflated. Inflation was caused by the small amount of residual air left inside the balloon and by 30 pounds of sublimating powders. The 100-ft. sphere, orbiting at 1000 miles altitude, is made of plastic



film and has two tracking beacons attached. The sphere's aluminum coating provides radio wave reflectivity of 98 percent up to frequencies of 20,000 mc.

Using both radar and predicted orbit data, Bell scientists located the balloon as it sped across the sky at 16,000 miles an hour. They aimed the 50-ft. long horn reflector receiving antenna directly at the orbiting sphere and received the JPL signal. JPL transmitted on a frequency of 2390 mc/sec. by means of an 85-ft. parabolic antenna.

The successful communication occurred as the sphere cut diagonally across the North American continent, from Northwest to Southeast, on its first pass around the Earth. Echo orbits in about two hours.

In his message, the President noted the experiment as "one more significant step in the United States program of space exploration," carried out, he added, "for peaceful purposes for the benefit of all mankind. The satellite balloon which has reflected these words may be used freely by any nation for similar experiments in its own interest."

The Project Echo experiments are being conducted by the National Aeronautics and Space Administration, Bell Telephone Labs., (see SIGNAL, July 1960, page 44) and the Jet Propulsion Laboratory.

## What's Over the Sun?

(Continued from page 31)

them as perturbations to their measurements but rather to study ionospheric conditions. And as we learn more about the various ways solar disturbances affect our terrestrial environment, we need solar astrophysicists interested in geomagnetism as well as magnetohydrodynamics. The interest in space has also brought about renewed interest in celestial mechanics and in the need for a more accurate determination of the astronomical unit (the distance from the sun to the earth).

The study of magnetohydrodynamics, or hydromagnetics, which frequently includes plasma dynamics, was started by Alfvén as a study of astronomical problems—the study of the motion of an ionized gas in the presence of magnetic fields. His work was preceded by Appleton's magnetoionic theory for the ionosphere. Within the past five years considerable work has been done in this area and theories are now developed for the study of either fluids or ionized gases in the presence of magnetic fields (either external or self fields). The applications of these theories spread over many disciplines.

Appropos the new name, plasma physics, for this old facet, it is interesting to note that most astronomers smile at the physicists' reference to a plasma as the new "fourth state of matter." What is the most natural form of matter in our universe as a whole: solid, liquid, or neutral gas? It's none of these; it's partially and wholly ionized gases. Our earth is one of the few places for unnatural, nonconforming matter! (*Deo gratias!*) Of course the plasma physicists are now producing these heavenly conditions in the laboratory, albeit for extremely short periods of time.

Until recently, we knew little about interplanetary space. We knew that the earth was one astronomical unit away from the sun (by definition), and that it had an ionosphere which could be studied only up to the F2 reflection layer (about 250 kilometers up). Theorists had ventured some ideas about a ring current a few earth radii away, which is still a very small distance out. From the sun's end we knew that the solar corona extended about 5 or 6 solar radii from the sun's surface—this is about 0.02 astronomical units. For the rest, about 98% of the distance, interplanetary space seemed sufficiently empty not to worry about it. But this feeling has changed. Evidence has come from several sources: 1. observations of lunar radar echoes and of "radio stars" have made it

possible to study the entire ionosphere (and there's more above the F2 maximum than we thought), 2. whistlers give evidence of the density about one earth radius above the earth, 3. eclipse photographs in the red and infrared taken at high altitudes show the corona extending out to at least 18 solar radii, 4. radio observations of the Crab Nebula just before its eclipse by the sun showed that at 20 solar radii the solar corona affects the observations. Suggestions for explaining the zodiacal light now assume greater densities for interplanetary space and studies of cosmic rays have shown that the interplanetary medium affects both the galactic cosmic rays and the cosmic rays from solar flares.

## Astronomical Windows

People often forget that our knowledge of the universe depends on studies over a rather short wavelength interval. When we look at Figure I, (all figures, pg. 39) showing the astronomical "windows" of the electromagnetic spectrum through the earth's atmosphere, we easily see why this atmosphere does not help our observations. Actually most of the observations have been made at wavelengths between 3000 and 9000 Angstroms (or 0.00003 to 0.00009 centimeters). While we recognize that as humans we couldn't live without those two absorption bands (and also that ionospheric reflections help the communications industry), as astronomers we'd like to escape the limitations. Think of the observational possibilities on the other side of the moon! Of course some shielding from cosmic rays and proton clouds would be desirable.

Figure I also shows our new window—the radio-astronomy window. Radio astronomy was born in 1931 when Jansky, of the Bell Telephone Laboratories, discovered extraterrestrial radio noise at a wavelength of 14.7 meters. Although astronomers expressed interest in this, little was done to promote further research on the subject, and work was carried on solely by Reber, an engineer who built his own equipment in his back yard and in his spare time. The development of radar during World War II brought about new techniques of value for radio astronomy and also brought about that new species: the radio astronomer, who, more often than not, was an electronic specialist. Until recently most astronomers were extremely reluctant to slide along the em spectrum to that place where they talk about frequency instead of wavelength.

Radio astronomers have already made fundamental contributions to astronomy. To study the structure of the galaxy, it is necessary to determine the plane of the Milky Way. Although the stars are concentrated toward this plane (and younger, hotter ones more than the older), the gaseous layer is even more highly concentrated. Using observations of this gaseous layer, radio astronomers have made a better determination of the galactic plane than can be obtained from any type of star. This newly-defined plane has recently been adopted by international agreement.

Observations of Jupiter have been made at several wavelengths: 3, 10, 21, 32, and 68 cm., among others. The measured temperatures at 3 cm. give a black-body temperature of about 180°. This measurement is in reasonably good agreement with temperatures measured in the infrared and is interpreted as thermal emission from ammonia in the region near the top of the cloud layer.

But measurements at 10 cm. gave a temperature of about 600°. And then measurements at 21 cm. gave temperatures in the range 2000-3000° Kelvin; at 32 cm, as high as 5000-10,000°K; and at 68 cm, about 70,000°K. Now, it is obvious that these readings could not be due to thermal radiation. Since there are not too many ways of generating radiation nonthermally one usually postulates either synchrotron or Cerenkov radiation. Either case involves relativistic electrons in a magnetic field. For Jupiter the radiation is presumed to originate as synchrotron radiation from relativistic particles trapped in the Jovian magnetic field. This field is similar to the terrestrial Van Allen belts, which were detected at about the same time.

But radio astronomers have their problems. First, most of the radiation is very weak in intensity. The flux is usually measured in units of  $10^{-26}$  watts per square meter per cps. Signals are often measured as low as  $10^{-4}$  microvolts per meter. So the radio astronomer is interested in the development of low-noise receivers, such as MASERS and parametric amplifiers. Another boost to signals has been the use of traveling-wave-tube radiometers, where the signal is increased by using a wider bandwidth (several hundred megacycles). Unfortunately, this introduces another problem—interference. In some places this problem is sufficiently great for radio astronomy to be more limited than optical astronomy as far as observing time is concerned—observations can usually be taken only from midnight to 4 a.m.

## What's Over the Sun?

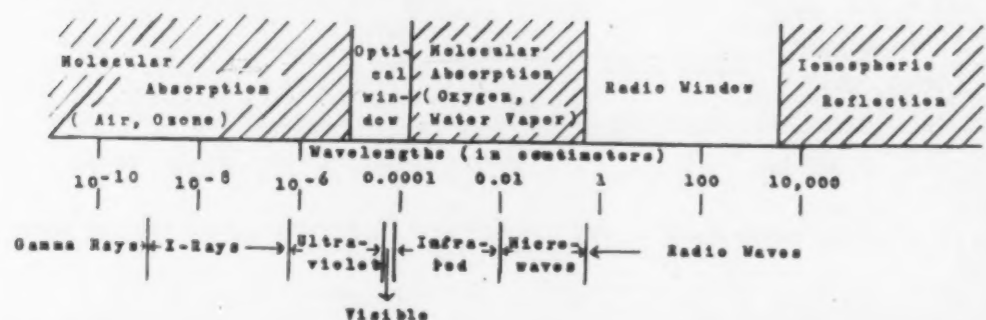


Figure I. (top L.) Atmospheric effects on the electromagnetic spectrum.

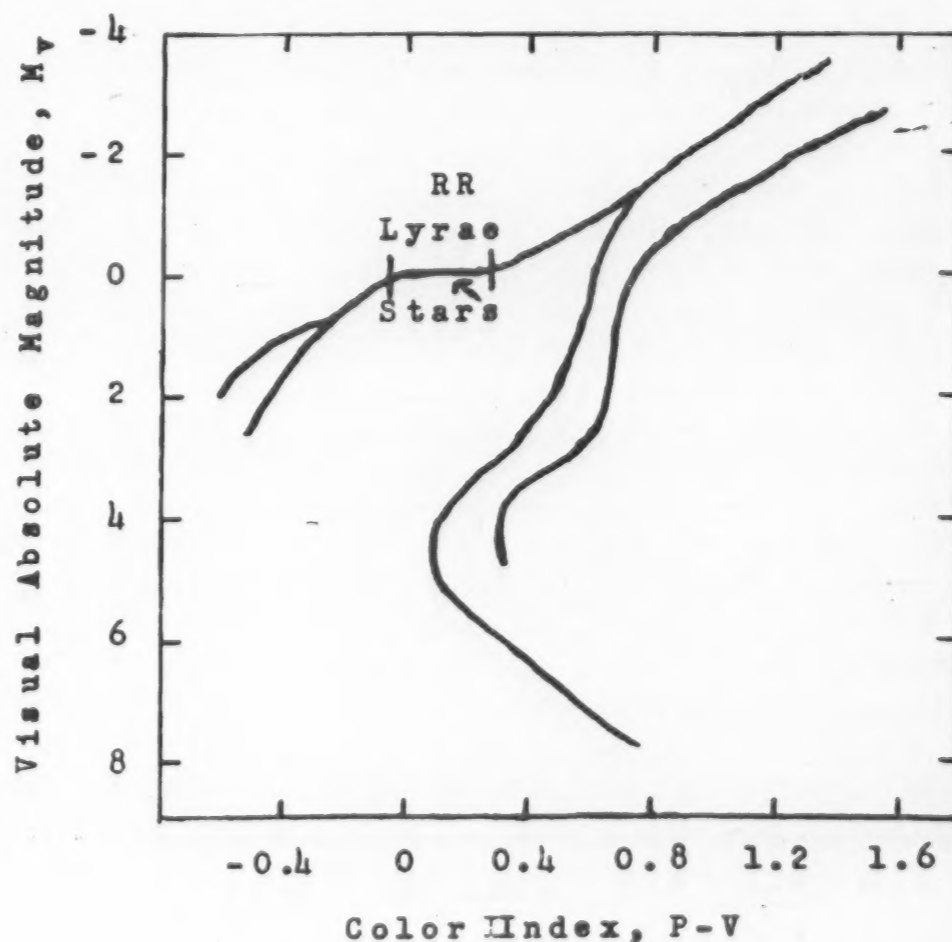
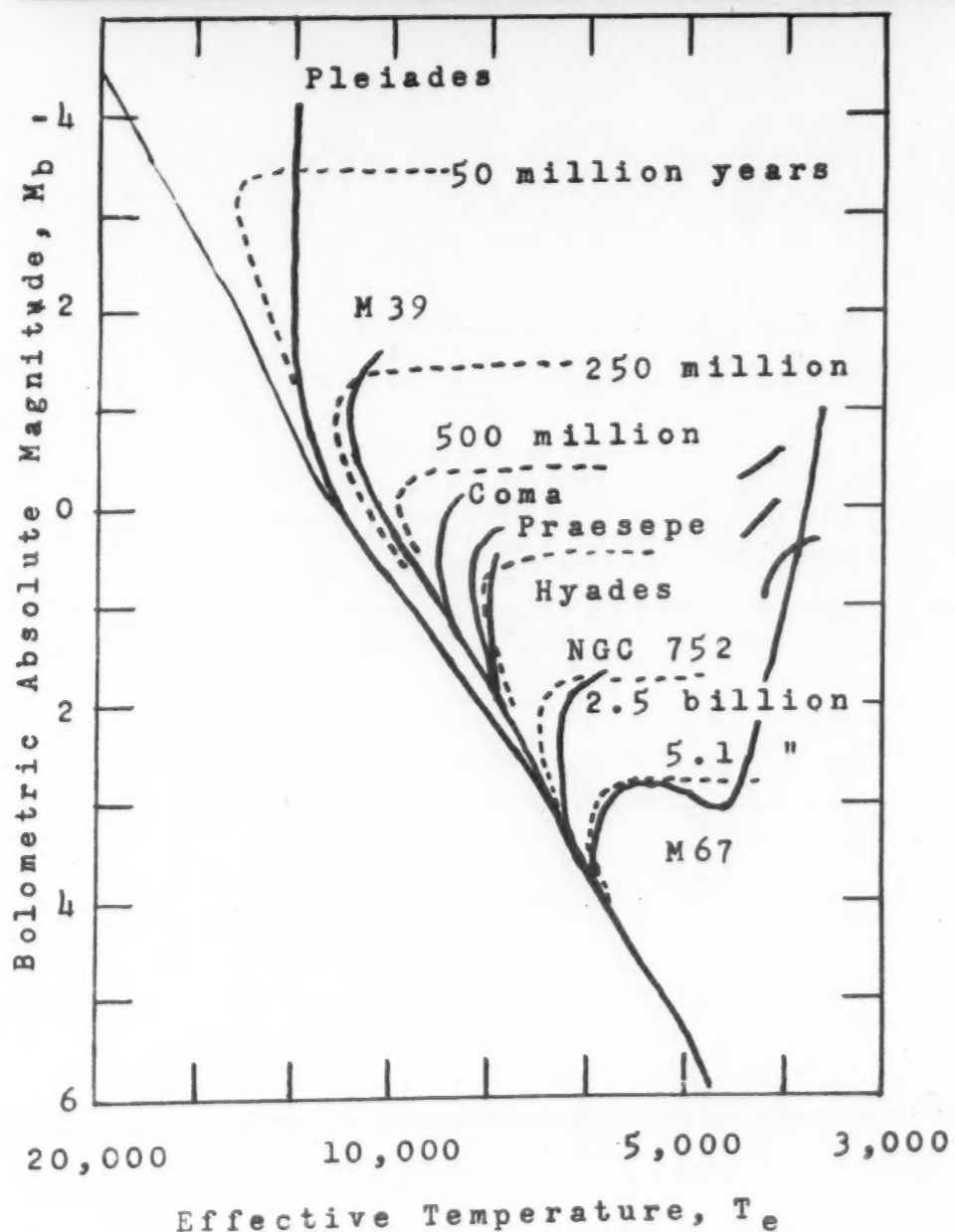
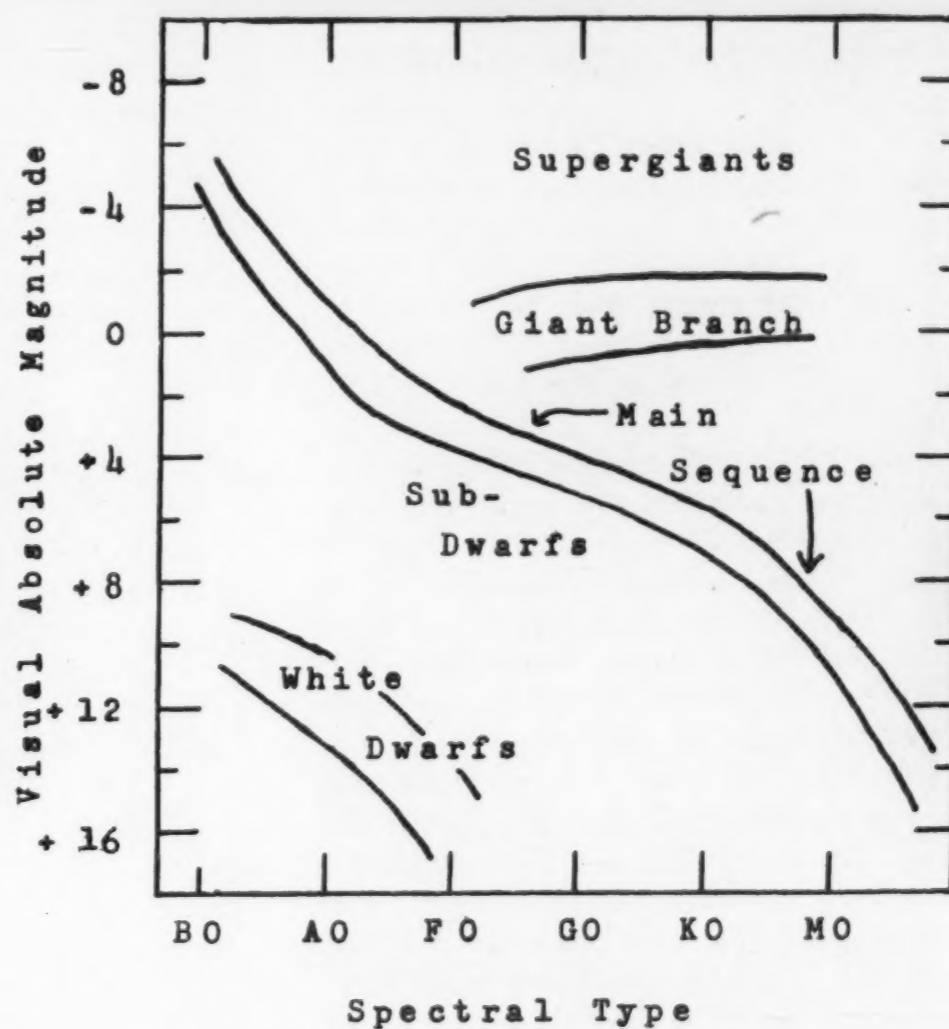
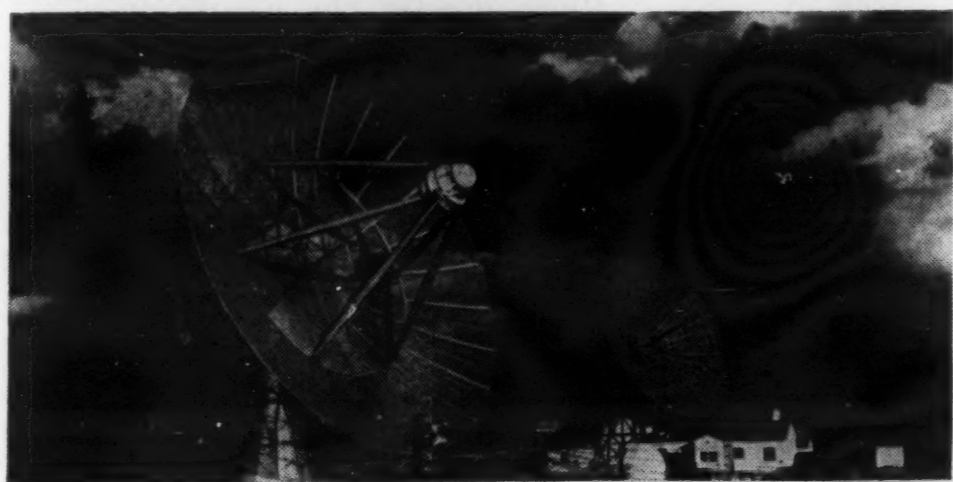
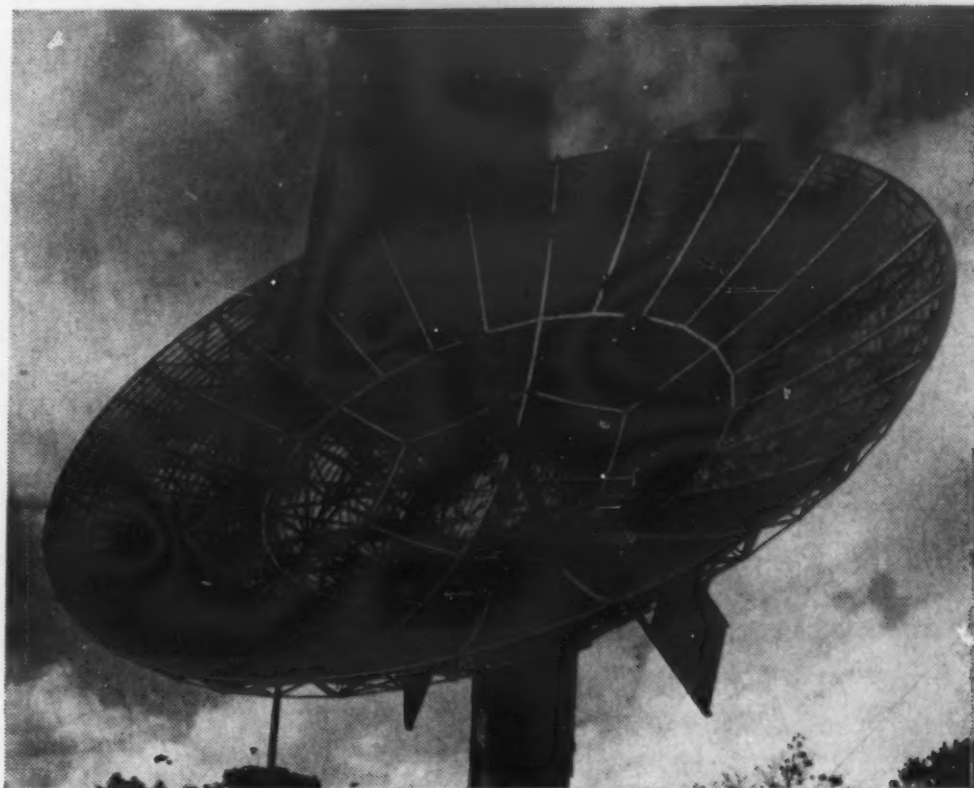
Figure II. (top R.) the 60' dish at USASRD, which was first used for measuring hydrogen in the Andromeda

Figure III. (middle L.) Present appearance of the 50' and 60' dishes.

Figure IV. (middle R.) A schematic Russell diagram giving the names by which the principle varieties of stars in the neighborhood of the sun are generally identified. One could also plot the surface temperatures on the abscissa as well as the spectral type.

Figure V. (bottom L.) Schematic and theoretical diagrams for some open galactic clusters. The clusters converge toward the fainter end but there are great differences in the upper regions of the main sequence. The dotted lines show the theoretically predicted diagrams for star clusters of various ages. The dotted line between the plot of the Hyades cluster and Praesepe represents the one billion year calculation.

Figure VI. (bottom R.) Color-luminosity diagrams for a few globular clusters. The position of these RR curves on the diagram is based on assumptions concerning the RR Lyrae stars; i.e. that they are at 0 absolute magnitude. Other globulars differ from these plotted, some having a much greater scatter. Most of this work was based on data assembled by Sandage and colleagues at Mt. Wilson and Palomar Observatories.



To the radio astronomer, it's man that makes our "noise" as we try to listen to the "music of the spheres," which is usually called extraneous radiation by the communications engineers. The radio astronomer wants to utilize the electromagnetic spectrum by listening, not by broadcasting. He further wants to enjoin others from superimposing noise on his weak signals. Of course, some may not consider this to be efficient spectrum utilization! Many astronomical objects radiate signals over the whole radio spectrum. To obtain the best scientific knowledge of such objects, we must observe at as many different frequencies as is reasonably practicable. If we had observed Jupiter only at 3 cm, we would not have known of the nonthermal radiation.

Some objects radiate particularly at 1420 mc/s, the frequency of radiation of radio waves from hydrogen gas. The observation of this radiation is one of the most productive subjects for study by radio astronomers. Of course this frequency is the stationary position: if the hydrogen gas is receding, the frequency is lower. To measure a red shift of about 17,000 kilometers (Cygnus A), we must look for the hydrogen line at about 1340 mc/s rather than at 1420. The hydrogen line is the only one thus far observed but it has been predicted that others might be found for deuterium (heavy hydrogen) and the OH radical. We hope that current laboratory work in the spectroscopy of free radicals will expand the list of possibilities. The diatomic radicals of carbon, hydrogen and nitrogen have been optically detected in the galactic medium and have spectral lines in the millimeter wavelength region (i.e., EHF or 30 to 300 kmc).

Figure II shows the U. S. Army Signal Research & Development Laboratory's 60' in diameter dish, which was first used for measuring hydrogen in the Andromeda Nebula, a spiral galaxy similar to our own about one million light years away. It is adjacent to the 50' in diameter Diana, which is located on the site of the first radar to bounce a signal off the moon. Diana is now used for exploring radio-propagation phenomena; e.g., transmitting signals twice through the ionosphere to the University of Illinois via the moon. This dish was also used to assist in calibrating the Minitrack stations prior to the Vanguard launchings by means of a 108-mc/s signal beamed to the moon, using the moon as an artificial, artificial satellite.

Figure III shows the two dishes as

they appear today. The 60' dish is presently one of two being used for Project Tiros; the other one is in Hawaii. A parametric amplifier is being used with the 50' dish to increase the strength of signals from objects such as Cass A (wisps of gas about 10,000 light years away) and Cygnus A (two colliding galaxies about 270,000,000 light years away).

And what have the cosmologists and cosmogonists been doing? The newest and most important current trends in astronomical research are concerned with the expanding universe, the cosmic time scale, stellar evolution, and studies of non-thermal radiation. Studies of the cosmic time scale depend on the various world models. A model (Milne, Einstein-deSitter, steady state) must be assumed before an age can be assigned to the expanding universe from our knowledge of the present expansion rate.

For a couple of generations before the war, the physical properties of the stars were the main concern of astronomers. No one dared to interpret these physical properties in terms of evolution. Evolutionary theories have been developed on the basis of the variety of spectrum-magnitude diagrams of galactic clusters. The picture has gradually been refined and now we believe that the sequence of clusters is an evolutionary one. In the present era we are concerned with the interpretation of these spectrum-magnitude diagrams and of the mass-luminosity relation, in contrast to the previous era when the emphasis was on the physical properties. Even before that time, the stress was on the structure of the galaxy. These could be considered the three great eras of modern astronomy.

We must realize that almost all our knowledge of stellar evolution depends at present on comparing the properties of stars of different ages. Evolutionary changes in single stars have only been ascertained in novae and supernovae. Little is known about evolution in other types of individual stars. The best hope lies in studying variable stars, especially those whose period can be determined with very great precision. For example, the period of Beta Lyrae has been observed to increase steadily over the last 200 years and this change can be attributed to a loss of mass. However, the data known at present are ambiguous; one star may show successive increases and decreases of period.

Clusters have become very important to us for evolutionary purposes, as they furnish one of the most im-

portant methods of dating stars in our galaxy. Certain regions of the universe (such as the vicinity of the sun) have a great deal of interstellar matter, composed of gas and dust clouds. These serve as the source for the formation of new stars by a slow condensation process. Other regions of the universe have stellar groups that contain no interstellar matter, for example open galactic clusters and globular clusters. It seems that the formation of these clusters of stars took place all at once in some distant past (the time varies from one cluster to another) and all the available material was used up. Thus the stars in any one cluster are all of the same calendar age and no new stars can be formed within such a group. In the vicinity of the sun we have stars of all ages.

### Classification of Stars

Let us look at our present knowledge of evolutionary history of the stars. Since stars in one cluster are all of the same calendar age, the stars of different masses belonging to it show a clear picture of their "genetic" age differences. Stars of different masses go through their evolutionary cycles at different rates and their total life span depends on their masses.

We are able to classify stars by studying that portion of the electromagnetic spectrum within the narrow limits of frequency known as visible light. By studying stellar spectra we are able to classify these stars in a two-dimensional fashion: on the bases of the surface temperature of the star and the star's density. We assign spectral types to most of the stars—O,B,A,F,G,K,M,N,R, or S—and further label them as to whether they're giants, supergiants, dwarfs (also called main sequence stars), or subdwarfs. We can plot the absolute brightness of a star (the brightness it would have at a specific distance) against its spectral type, surface temperature, or color. For most of the stars in the vicinity of the sun we'd get something like Figure IV, with the stars lying within the bands shown. This is similar to a diagram Adams and his associates at Mt. Wilson found in 1932 for about 4,000 stars and confirms fully that first drawn by Russell in 1913. Such diagrams are frequently called Russell diagrams or Russell-Hertzsprung diagrams. Most of the stars fall within a narrow band known as the main sequence. Our sun, Sirius, Rigel, and many other stars belong to this sequence. There is very little variation of density among stars in the main sequence. However, when we

look at a star like Antares, we see that such a star must have an extremely different internal structure. These stars are situated far to the right of the main sequence and are known under the general name, Red Giants: red because they have a low surface temperature and giants because of their abnormally large geometrical dimensions and very high luminosity. When we consider the measured mass for Antares, we find that the material is extremely rarefied. While the mean density of our sun is 1.6 with respect to water, the mean density of Antares is only 0.02 compared to atmospheric air.

In contrast to the Red Giants are the so-called White Dwarfs, which are located in the lower left corner of the Russell diagram. A typical representative of this class is the companion of Sirius (Sirius B) which, having a mass almost equal to that of the sun, is only slightly larger than the earth. Thus its mean density is 500,000 times greater than that of water! This is a degenerate gas. For comparison, the density of lead is eleven times greater than that of water and the most dense elements are platinum (21.4 times water), iridium (22.4 times water) and osmium (22.5 times water). Such high densities can be achieved by material when the atoms are completely broken into free electrons and bare atomic nuclei. It has been estimated that about 5% of all the stars in the sky are in the collapsed white-dwarf state, but because of their extremely low luminosities, only about a dozen of them, which are comparatively close to us, have been observed. The white-dwarf section of the Russell diagram has been referred to as the astronomical graveyard. These stars are the dead, albeit still warm, bodies of brilliant stars of the past that are now gradually cooling down to total oblivion. We also call them degenerate, cold bodies.

In order to date stars we must know how they radiate. We haven't known the answer to this for very long. In 1929 it was shown that at the temperature in the sun's interior, thermonuclear reactions between hydrogen nuclei (protons) and the nuclei of other light elements can be expected to liberate sufficient amounts of nuclear energy to explain the observed radiation of the sun. However, the exact nature of these reactions was not known because of the lack of experimental knowledge concerning the result of nuclear bombardment by fast protons. In 1937 Bethe in the U. S. and von Weizsacker in Germany independently proposed one possible solution, now

known as the carbon cycle. Another possibility was proposed by Bethe and Critchfield, and is known as the H-H reaction. Both of these are of importance in stellar radiation. The net result of both reactions is the transformation of hydrogen into helium (fusion), although it is achieved in a different manner in each reaction.

In carbon cycles, the carbon acts as a catalyst that helps unite four protons into a single alpha particle by capturing them one by one and holding them together until the union is achieved. After the four protons are caught and the newly-formed alpha particle is released, the carbon is available for the next cycle. Calculations show that the rate of energy liberation for the sun by this process is only one percent of the observed energy production in the sun.

#### H-H Reaction

The first step in the H-H reaction is the formation of a deuterium nucleus in the process of thermal collision between two protons. This is followed by a series of thermonuclear reactions that build up the deuteron into an alpha particle. For this process the total rate of energy liberation for solar conditions is about 100 erg/gm sec, which is about equal to that believed to be generated in the central regions of the sun.

Thus, for the sun, the H-H reaction is the predominant one. This is not true for all stars. These two sets of thermonuclear reactions possess different sensitivities to temperature. While the rate of the H-H reaction increases comparatively slowly with increasing temperature, the rate of the carbon cycle goes up very rapidly.

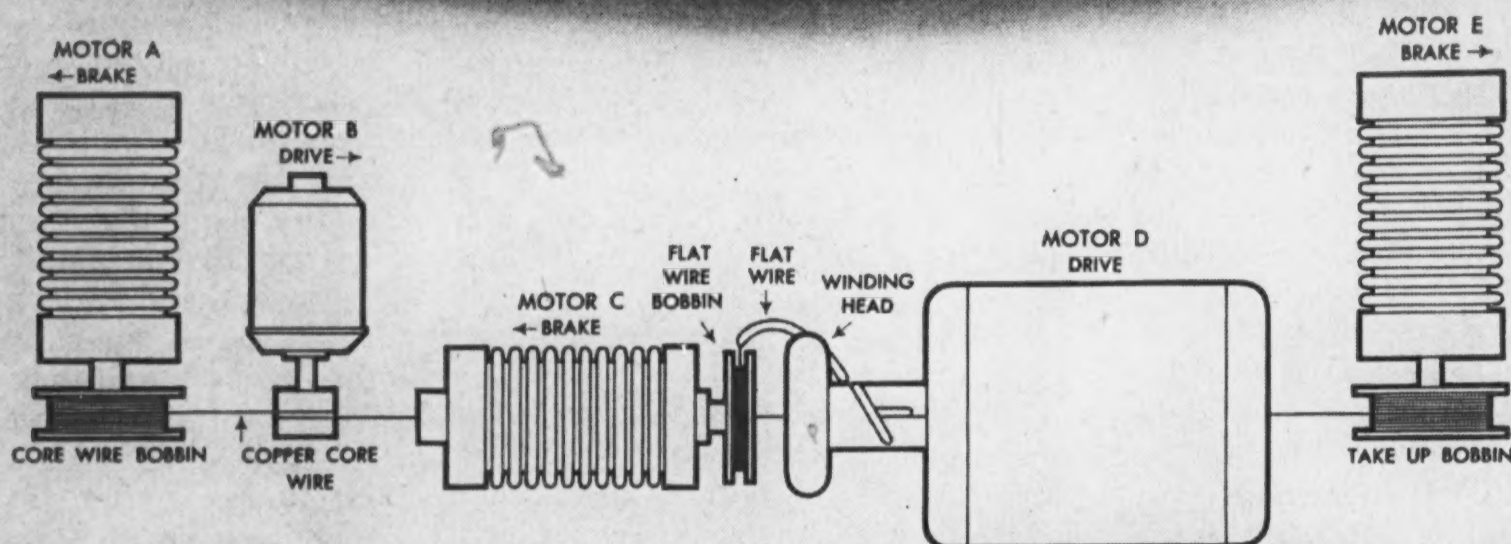
When we plot Russell diagrams for stars in open clusters or globular clusters we find some stars that are in different parts of the diagrams. When we plot different open clusters we find some clusters with no bright blue stars (the upper left part of Figure IV), for example Hyades and Praesepe, and no stars as bright as absolute magnitude,  $M = 0$  (that is no star as much as 100 times as bright as our sun). Figure V shows plots of seven galactic open clusters. We began to suspect that we were observing stars of one age within one cluster, because we expected the brighter ones to "burn out" faster. This possibility of evolutionary significance in the "bending over" of the curve (we also call it "departure from the main sequence") was investigated. In 1955 Oke published a paper wherein he computed evolutionary trends. He gave two diagrams side by side; one was similar to Figure V, the other

was of an entirely theoretical nature, indicated in Figure V by the dotted lines. These were based on the calculations of Sandage and Schwarzschild, who assumed that at their "birth" all stars of a galactic cluster would be located upon the main sequence line that runs diagonally down from left to right in the diagram. Initially the stars would all remain close to the original main sequence. The intrinsically brightest stars—in the upper lefthand part of the diagram—will exhaust their hydrogen supply the quickest, and they will move rapidly to the right of the diagram. Still later they will really go down in brightness. After 50,000,000 years there will be no stars brighter than  $M = -0.5$ . Thus we can deduce from Figure V that the Pleiades are no older than 50,000,000 years, and that the Hyades may well have existed for something of the order of 1 billion ( $10^9$ ) years. Needless to say, the final word is still far from being said about stellar evolution in galactic open clusters.

Whereas there are at most two or three thousand stars in the richest galactic open clusters, a globular star cluster may contain as many as 100,000 stars. As of September 1959, 118 clusters in our galaxy were designated as globular. They are distributed in a spherical shape around the center of our galaxy and form a spherical system of their own as opposed to the pancake-shaped Milky Way. At a meeting of the American Astronomical Society in Toronto last September, a whole afternoon was spent discussing globular clusters and the differences among them. At the conclusion, we were unanimous in agreeing that one should not believe too much of what was previously believed, especially if it said "All globular clusters . . ." Of course astronomers usually say, "a typical globular," but within the past few years astronomers have seen very great differences for globular clusters in integrated spectra, in intrinsic colors, in periods of the RR Lyrae stars, in appearance, and in the shape of their Russell diagrams. Some of the differences were also believed to be due to chemical composition—e.g., metal-rich stars. Further we now recognize that a single cluster may contain stars of different ages and chemical composition. As Sandage put it: the problem of interpretation appears to be more complicated than we thought only a few years ago.

Figure VI shows a color-magnitude diagram for a few "typical" globulars. One can see that while the clusters differ somewhat from one another

(Continued on page 43)



**Problem:** To build a production line that will wrap delicate (breaking strength 3 oz.) "microscopic," computer "Twistor Wire"—gently, accurately, speedily.

**Solution:** The line diagramed above. Here's how it works:

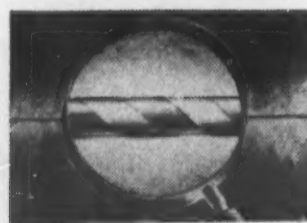
1. To start line, Brake Motors A and E pull the copper core wire taut. The flat magnetic wire is already wrapped a few times around the core wire. Brake Motor C pulls back on the flat wire bobbin holding both wires tense and motionless.

2. Wrapping begins when Drive Motor B starts core wire moving in synchronism with Drive Motor D, which revs up winding head to 6,000 rpm.

3. The Key: Brake Motor C maintains uniform, gentle tension (20 gr.  $\pm$  2 gr.) on flat wire because its response is faster than that of the Drive Motors.

**Result:** A "dynamic tension" production line that gently wraps Twistor Wire at  $92.7 \pm 3$  turns to the inch—producing some 300 feet of magnetic memory wire per hour with an information capacity of at least 28,800 "bits."

## How to build a better memory



**Hair-Like Twistor Wire,** magnified 33 times, forms heart of new electronic computer memory device.

Western Electric has begun production of a new memory storage unit for complex electronic computers that is less expensive than other memory components now in use. The heart of this memory is the "Twistor Wire" (left) which is produced by wrapping a hair-thin (.0035") copper wire with an even thinner (.0003") flat magnetic wire. Scientists at Bell Telephone Laboratories, Western's partner, discovered that separate "bits" of information could be stored as close as every 1/8th of an inch along Twistor Wire—a discovery that will have a significant impact on the entire computer industry.

To be practical Twistor Wire had to be produced in large quantities and at low cost. Working with a model 100 times larger than the finished production model,

Western Electric's engineers evolved the solution—a wrapping machine (above) so small it can fit on a desk top. Three torque (brake) motors and two synchronous (drive) motors, held in dynamic balance by nothing more than the tiny wires they wrap, turn out the desired product to ultra-precise specifications at the rate of 300 feet per hour.

The successful production-line manufacture of Twistor Wire is one more example of Western Electric's many new developments in design and engineering techniques.

# Western Electric

MANUFACTURING AND SUPPLY



UNIT OF THE BELL SYSTEM

## What's Over the Sun?

(Continued from page 41)

other, there is a much more striking difference from the Russell diagram for the stars in the neighborhood of the sun. We have been able to study the globulars in detail only since the advent of the 200" telescope at Palomar, and even with this telescope we must take four-hour exposures.

When we look at the diagram we see two rather striking features: a vertical branch and a horizontal branch. The nearly vertical branch goes from the giant to the subgiant branch with nearly constant color for a range of about four magnitudes in absolute magnitude. There are no stars brighter than about 3.5 on the main sequence. From this we believe that the globulars contain the oldest stars and that many of them have evolved from the main sequence. For the fainter stars, the main sequence lines for different globulars run parallel to the main sequence in Figure IV but at varying distances below and to the left.

The other feature is the "horizontal branch." All the stars here are at about 0 absolute magnitude (there's recent evidence that this is not so for all globulars), and, what is more surprising, all these stars are variable, most of them periodic variables similar to RR Lyrae. Schwartzschild has suggested that stars of this particular range of temperature and luminosity must pulsate and be unstable: hence they become variable stars—the instability lasting for a few millions of years. Then the stars become stable again, less luminous, and finally fade away. If we look at Figure IV we don't find many stars in this region.

Stars depart from the main sequence because of their age, mass, and chemical composition. Since the energy radiated by a star is due to the continuous transformation of hydrogen into helium, we know that it cannot shine forever. During the five billion years of its existence, the sun has used up about half its original supply of hydrogen, so it still has enough nuclear fuel in the form of hydrogen for another five billion years. What then? It grows! The thermonuclear reactions take place almost exclusively in the central regions of the star, where the temperature is the highest. Hence the shortage will first be felt there, when the hydrogen will all be transformed into helium. Then the high-temperature region will move to the interface between the "burned-out" core and the outer-layers that still contain enough hydrogen to maintain a nuclear fire. The star will then change from what we call a point-source model (with

the energy source in the center) to a shell source model, where the energy is released in a thin shell that separates the core from the rest of the stellar body. As more and more hydrogen is transformed, the "shell" moves outward.

### Lifetime of Stars

What do we now suspect about stellar evolution? The lifetime of a star is governed by its mass. We've found that the range in stellar masses is rather restricted—with few exceptions it varies from about 2/5ths to 4 times the mass of the sun. The ranges in stellar luminosities, densities and temperatures are much greater. And for any one star its mass does not decrease too much during the course of its life; the change being but a few percent.

First the stars condense from a mixture of gas and dust and reach a steady state (the main sequence) in which they consume their original hydrogen supply by means of carbon cycles or H-H reactions. A star may form with either highly massive or less massive concentrations—the higher the mass, the greater the luminosity. Thus stars of different masses go through their evolutionary cycles at different rates. According to observationally established and theoretically confirmed mass-luminosity relations, the brightness of the stars, and hence their rate of hydrogen consumption, increases as the cube of their mass. Since the original supply of hydrogen is more or less proportional to its mass, we must conclude that the total life spans of different stars must be just about inversely proportional to the square of their masses. There seems to be little doubt that for stars obesity makes for a shorter life. The more massive a star is, the faster it consumes its energy and expires and from theoretical considerations we also know that it has to have a more violent death (eruptions, explosions, etc.) than stars with masses similar to the sun's.

Thus the amount of time a star stays on the main sequence depends on its mass. We think the sun has been there for about 4-5 billion years and has another five billion to stay. The intrinsically brighter stars (i.e., the more massive) will exhaust their hydrogen supply more quickly and will move to the right in a Russell diagram—i.e., they will evolve off the main sequence. At this stage they will become physically larger and more luminous. Then, if not too massive, they will pass through certain unstable phases (e.g., RR Lyrae) to the graveyard of white dwarfs. One astronomer, while lecturing on RR

Lyrae stars said: "These stars are restricted to, and fill, a definite domain in the horizontal branch. One evolutionary idea is that the RR Lyrae stars are moving from right to left along the color-magnitude array. Probably they are moving in one direction or the other." Most astronomers do believe that they are moving from right to left.

We also know that there is an upper limit to the mass of a star that can cool off—this is predicted by the theory of relativity. So the massive stars must get rid of their surplus mass in some fashion. We suspect that this may be the source of novae, supernovae, expanding shell stars, etc. but we don't know exactly where (on the Russell diagram) or how often they become unstable.

Needless to say, no astronomer would vouchsafe to believe ten years from now his present ideas on stellar evolution.

Let us not have a blind faith in technology. We must remember that research must precede technology and that research must be conducted by competently educated (not merely trained) individuals with a moral conviction that our freedoms are vital and precious quantities. All of us have a responsibility to see that more people recognize that we are in competition, that we must encourage our children to cherish their freedom and to pursue excellence. Perhaps we can convince them that Aristotle's definition of happiness is best: "the exercise of vital powers along lines of excellence in a life affording them scope." We cannot rest on past progress. Those who will be the leaders will be those who explore the unknown most diligently. The prosperity of our country depends on the status of our research programs, which in turn depend on our having an informed public to give support to an adequate number of excellent scientists.

We can never minimize the importance of education. Aristotle had a few words on this subject too: "All who have meditated on the art of governing mankind have been convinced that the fate of empires depends on the education of youth." His ideas were later echoed by Napoleon, among others: "Give me the education of the children and I will control the state." These ideas are still true today; we must uphold the ideals of individual character, integrity, and scholarship.

So onward and upward, excelsior! And please don't "utilize" the whole spectrum—astronomers want to see out those windows!

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# Prodelin - Prodelin EVERYWHERE...

## It Makes You Stop and Think

Everywhere you turn, you see more and more Prodelin equipment being used for RF transmission. Coaxial cable, transmission line, connectors, antennas, and complete systems are all in heavy demand because of Prodelin's superior specs and performance... better price and delivery. Review your own needs and you'll see that Prodelin can do the job better for you!

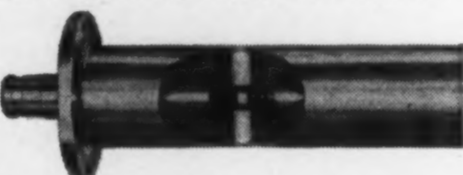
### Prodelin Spir-O-Line® Spir-O-Lok® SEMI-FLEXIBLE ALUMINUM COAXIAL CABLE & CONNECTORS



Whether your problem is weight, attenuation or power, Prodelin Spir-O-Line does the job better. With Spir-O-Line, you increase your system and aircraft range by reducing attenuation and weight. 1/2" Spir-O-Line weighs only 12 lbs./100 ft. . . . handles 400 watts average power with a loss of only 4 DB/100 ft. at 2 KMC. 3/8" Spir-O-Line weighs 34 lbs./100 ft. . . . handles 1 KW average power at 2 KMC. with a loss of only 2 DB/100 ft.

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### Prodelin Series 800 RIGID COAXIAL TRANSMISSION LINE



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New 4 1/4" line can handle 50 KW average power at 250 MCS, for great savings through less weight and smaller line size.

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To complement its already famous line of microwave antennas, Prodelin makes available its unique antenna package for 6 and 7 KMC. The package incorporates Spir-O-Line semi-flexible coaxial cable and Spir-O-Lok connectors for low loss and easy installation. Available in 4, 6, 8 and 10 ft. antenna sizes the system is particularly recommended for use in passive reflector systems or on other short runs. The new system greatly reduces engineering time and component expense.

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Prodelin's new series of VHF antennas include the ground plane, the unity gain coax, and the Omni-6. The Omni-6 is a collinear gain antenna designed to meet the need for a 6 DB gain antenna with a minimum of cost and wind loading. All antennas are corrosion resistant and terminate in type "N" connectors. All are capable of withstanding 100 MPH winds while giving superior performance. All connectors are protected by a metallic shield from installation damage and weather.

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## GLOBECOM IV



### SIGNAL Staff Report

A military commander must be able to command and control his troops, wherever they may be, in the quickest and most reliable way possible. However, not only the fact that troops are more widely scattered than ever before, but also the speed of delivery and destructive power of modern weapons systems require more elaborate and extensive communications systems. Methods of providing these world-wide communications systems were discussed at GLOBECOM IV, the National Symposium on Global Communications held in Washington, D. C., August 1-3.

A global communications network requires the use of many types of transmission systems. At two technical sessions emphasis was placed upon the role of satellite systems in a global network. A satellite system can provide the wideband capability necessary for the large numbers of high speed data and voice circuits, it was said. The majority of existing facilities are crowded and thus cannot provide this capability.

Communications requirements in the Air Force global system, AIRCOM, were examined and it was shown that a satellite system could be used to provide long range point-to-point communications as well as possible long range ground-to-air communications.

After establishing a need for satellite systems in the global communications network, industry and military authors discussed the relative merits of both active and passive satellite systems. It was stated that an active satellite system utilizing several satellites placed in a 24-hour equatorial orbit could provide coverage on a world-wide basis. This type of system would have certain advantages over the passive system. It would require less transmitter power to operate and would be less expensive than the passive system.

However, in some cases a passive satellite system might be preferred. In point-to-point communications, the passive system would provide greater reliability, according to one author. The passive system would be more reliable since it does not contain equipment within the satellite which would be subject to failure. All the equipment is at the ground station where it is easily accessible for repairs. In the active system, the inaccessibility of equipment within the satellite reduces the reliability of the system, it was said.

There is also the problem of jamming the system. Unlike the active system which operates on set frequencies, a passive system could change frequencies and thus the possibility of jamming the system would be reduced.

Other facts concerning satellite systems were discussed. A comparison of orbit configurations for satellite systems was given and it was concluded that a high altitude synchronous system presents less problems than a low altitude synchronous system.

In addition to the sessions on satellites, there were sessions on submarine cables, tropospheric communications, and interference and spectral problems. Other sessions were devoted to the design concepts necessary to provide the reliability, alternate routing and various types of services required.

It was disclosed that a new submarine cable system which can provide two-way transmission of information via one cable is being developed. Present cable systems require the use of separate cables for two-way transmission. This new

(Continued on page 68)

# LITHOCOM

## underground communications system



(Left): One of the first messages sent by the Lithocom system is presented to B. H. Oliver, Jr., AFCEA National President by L. H. Carr, DECO President. Looking on are Maj. Gen. H. W. Grant, USAF, Director, Communications-Electronics; RAdm. W. D. Irvin, Chief, Defense Communications Agency; K. B. Lewis, AFCEA Washington Chapter President; Maj. Gen. E. F. Cook, USA, Deputy Chief Signal Officer; W. J. Baird, AFCEA General Manager; RAdm. F. Virden, USN, Assistant Chief of Naval Operations (Communications)/Director, Naval Communications. (Right) Mr. Oliver reads the message as Mr. Carr and Colonel Baird watch.

ON JULY 28, 1960 a group of electronic engineers working 1,000 feet below the ground near Carlsbad, New Mexico, sent a message through the earth to a waiting group of engineers in a distant mine. It was the first time a message had been transmitted by radio waves propagating over a distance of more than 4 miles through the earth, and marked a new first in electronic communications development.

The first message, addressed to the President of the United States, was signed by Lester H. Carr, president of Developmental Engineering Corporation, developers of the new technique. Mr. Carr said:

"We send you this first teletype-writer message to be transmitted by radio waves propagating along a deep-lying substrata path 1000 feet beneath the surface of the earth for a distance of  $4\frac{1}{2}$  miles between two mines near Carlsbad, New Mexico. The sending of this message opens a new medium of communication, virtually indestructible and free from disturbances, for peaceful and military uses.

"We are proud to make this contribution to communications technology and to the growing body of scientific knowledge which has helped make and will keep this nation great."

The following message was sent to the Secretary of Defense:

"In recognition of the fact that communication is the lifeline of a nation we send to you one of the first teletype messages to be transmitted

by radio waves propagating along a deep-lying substrata path of approximately  $4\frac{1}{2}$  miles distance and one thousand feet beneath the surface of the earth between 2 mines near Carlsbad, New Mexico. This message demonstrates a new medium of radio communication — indestructible and free from disturbances. It establishes another 'arm of control for the voice of command.'

Lester H. Carr, President  
Developmental Engineering  
Corporation"

Similar messages were sent to the three service communicators: Major General R. T. Nelson, Rear Admiral Frank Virden and Major General Harold W. Grant. Rear Admiral W. D. Irvin, Chief, Defense Communications Agency, received the following message:

A new medium of communication has just been demonstrated near Carlsbad, New Mexico by successfully transmitting message traffic through a salt stratum lying some 1000 feet below ground level over a  $4\frac{1}{2}$  mile path. This message is one of the first to be transmitted through this medium. It is an inherently hard means of point-to-point communication. This new dimension is now a proven capability. DECO is proud to have thus contributed to defense communications.

Lester H. Carr, President"

Also, an inaugural message was sent to W. J. Baird, AFCEA General Manager.

This new medium of communication has been named "Lithocom" because of its use of the earth's substrata. Virtually impervious to disturbances, the subground communication system would also be a survivable system in the event of nuclear attack.

Developmental Engineering Corporation, of Leesburg, Virginia-Washington, D. C., and Boulder, Colorado, has been conducting its own substrata transmission experiments in mines near Carlsbad, New Mexico, sending signals  $4\frac{1}{2}$  miles through the earth, more than a thousand feet underground. Signals originate at the DECO transmitter terminal for the substrata test located in the Potash Company of America Mine and then by radio propagate through substrata formation to the receiving terminal in the U. S. Borax and Chemical Corporation Mine also about 1000 feet below the surface, a path distance of some  $4\frac{1}{2}$  miles. The transmitter in the PCA Mine is operating at less than 200 watts output.

It is well known that radio waves traveling along the surface of the earth penetrate only a relatively short distance into it—the extent depending on the frequency of the waves and the electrical characteristics of the earth. Thus the earth is considered an effective shield against electromagnetic propagation. DECO's achievement is partially attributable to the recognition of two basic factors: the low noise levels deep in-

(Continued on page 48, col. 1)

## Transit Navigation System

(Continued from page 20)

distributions of an equiangular (logarithmic) spiral slot over the entire surface of the sphere. The slot was obtained by depositing on the sphere (which is of RF transparent material) a suitable metallic coating in accordance with the desired pattern.

The payload assembly is made up of three major structural units: (a) the external shell, (b) the central support tube, and (c) the instrument tray (wheel-package structure). Figure 2 depicts a cutaway view of the satellite 1B. The spherical shell consists of two hemispheres constructed of  $\frac{1}{4}$ -inch cell nylon phenolic honeycomb core material sandwiched between two surfaces of Fiberglas cloth impregnated with a epoxy resin. Mounted peripherally about the equator are the solar generator panels.

The outer shell encounters significant temperature differentials during its travels through direct solar radiation and through the earth's shadow. To achieve the desired performance, it is necessary to minimize the temperature fluctuations within certain satellite equipment. Therefore, a critical design goal has been to reduce heat transfer between the outer shell and the instrument package.

The required ratio (1.0) of thermal absorptivity to emissivity of the shell has been achieved by painting the shell with silver and black paints. Silver is used for the antenna pattern, black for other areas.

Insulated aluminum discs are installed on both sides of the instrument tray as thermal radiation shields. Heat transfer by conduction is minimized through use of a Fiberglas support tube. The Nylon lacing between the external shell and the instrument tray is also a poor conductor of heat. Nylon lacing is also used for the same purpose between the oscillator package (Dewar flask) and the instrument tray. A novel and very effective insulating material, consisting of a sandwich of

alternate layers of Fiberglas paper and aluminum foil, is employed extensively as a radiation barrier.

The launching rocket vehicle for which the satellite was designed employs spin stabilization of the final stage of rocket propulsion. Upon injection of the satellite into orbit and separation from the expended stage, the satellite possesses a high rate of spin which, if not removed, would make Doppler analysis difficult. On the other hand, some small amount of rotation is desirable to ensure exposure of the solar cells to an average, rather than to a possibly adverse, sunlight incidence. Similarly, avoidance of temperature gradients from one side of the outer skin to the other requires some rotation. As a means of reducing the initial high rotational velocity to a slow, specified amount, a de-spin system is employed which consists of a pair of weights attached to lanyards wound around the satellite at its equator. In response to a timer signal, the weights are released and deploy along involute curves due to centrifugal force, thereby providing a restraining torque (through the lanyard attachments) which quickly retards the satellite's spin. By this process the satellite's total angular momentum is transferred into the weights. When the lanyards are completely unwound, they disconnect from the satellite and allow the weights to sail off into space.

The satellite electronics are powered from several separate energy sources for maximum reliability and minimum interference between systems. Redundant wiring is employed to increase reliability.

One system is powered by silver-zinc batteries assembled in separate pressurized compartments.

The "B" system operates from "D" size hermetically sealed nickel-cadmium cells. The voltages for the electronic equipment are provided by this battery, which is maintained fully or nearly fully charged by a bank of solar generators. The generator units are arranged on two 12-sided rings near the equator of the satellite. Each generator bank consists of series-connected silicon photo-

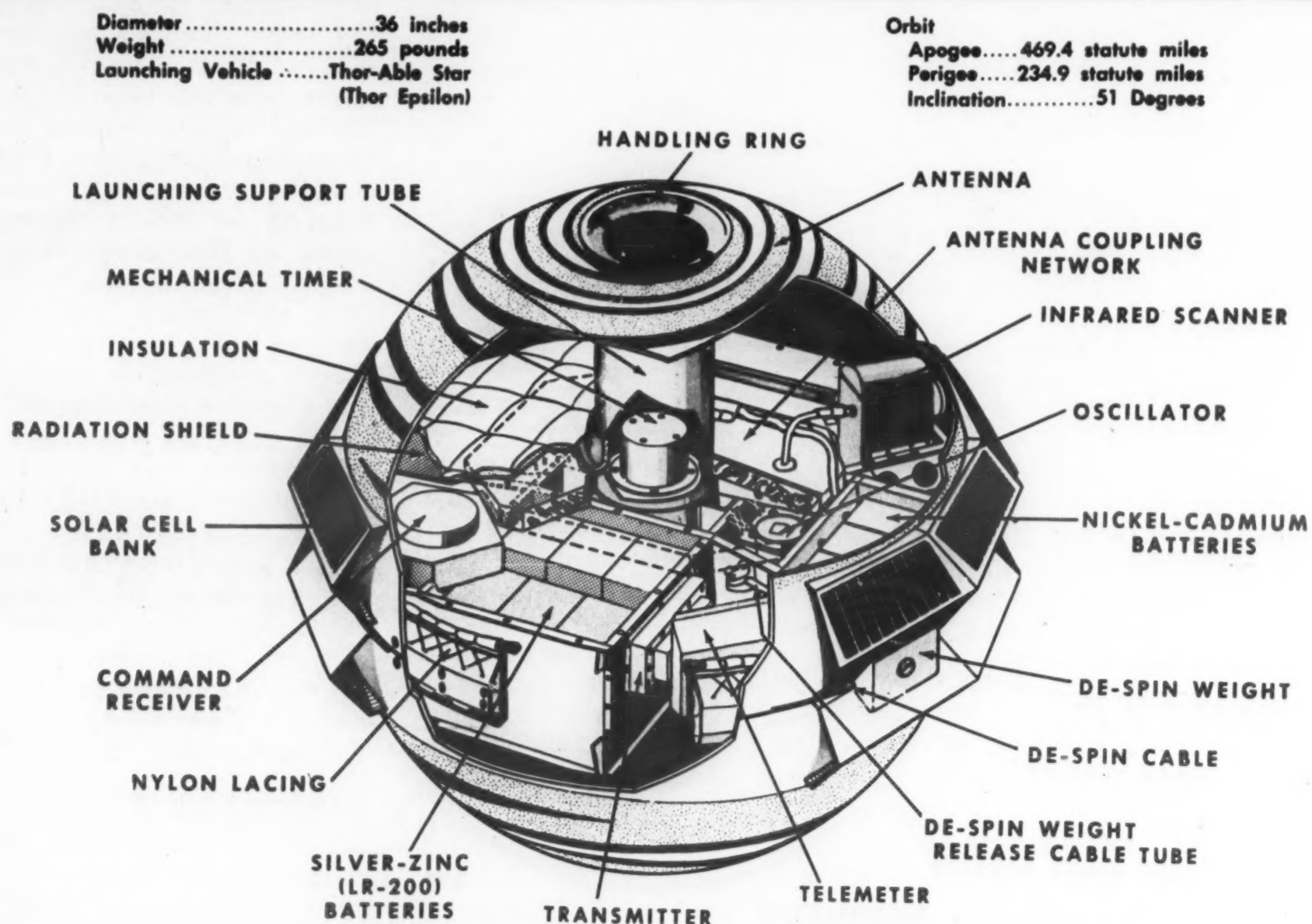


FIGURE 2.—TRANSIT 1B SATELLITE—CUTAWAY VIEW

voltaic converters mounted on an aluminum sheet metal structure by a ceramic cement. The cells are protected from micrometeoritic damage by fused silica windows. All generators are connected in parallel through silicon diodes which isolate the individual generator if its voltage drops below the bus voltage, due either to insufficient illumination or to damage.

Important differences in the various models are exemplified by the following: Twice the number of solar generators and one-half the silver-zinc (chemical battery) power supply in 1B than in 1A. The 2A power supply completely eliminated silver-zinc batteries and is dependent solely upon solar cells which are twice in number and more efficient than those in the 1B. Doppler frequencies were 54, 108, 162 and 216 mc in the 1A and are 54, 162, 216 and 324 mc in the 1B and 2A. A 108 mc telemetering transmitter has been added to 2A whereas the Doppler frequencies were employed also as the telemeter carrier frequencies on the 1A and 1B. The 2A in addition contains an electronic clock and a cosmic noise measurement receiver designed by the Defense Research Telecommunications Establishment of Canada. (In the 2A the receiver antennas are the de-spin weights.)

Unusual features first employed in 1B and improved in 2A are the use of permeable rods to remove residual spin after the de-spin weights have deployed and the installation of a permanent magnet in the satellite to insure that the satellite does not dwell in an unfavorable position particularly with regard to the solar cell system.

As noted in a preceding paragraph the 2A satellite launching included an auxiliary payload.

### Ground Test Program

The Transit ground test program was established with the objective of developing a sequential series of tests which when completed would culminate in the reliability required for a high probability of successful satellite performance in orbit.

To achieve this reliability the test conditions were predicated on (but did not necessarily duplicate) the environments of shipment, handling exposure at the launch site, launching and orbiting, plus a standard acceptance regime to demonstrate proper workmanship and manufacturing techniques.

Since guided-missile test and flight conditions are by now well known, it might be worthwhile to make a comparison of the basic environmental differences between them and the satellite. Such obvious differences as effective gravity, radiation (both solar and particle), and atmospheric pressure are well recognized. However, there are also more subtle differences as well as strong similarities.

There are two additional basic differences between guided missiles and this satellite, not of an environmental nature, which have impact on the test philosophy. One is that this satellite is in the development phase and, even when operational, will require manufacture of only small numbers of units, whereas guided missiles are typically produced in large quantities. The second is the complexity of the missile due to its guidance, control, and fuzing systems in contrast to this satellite, which has simple electronics and few mechanical operations.

Tests are made on *all* packages, assemblies, etc. that are allocated for flight use. These tests are intended to demonstrate proper assembly and workmanship, thereby employing an environment selected specifically for test purpose without necessarily attempting to duplicate that of flight. Whenever it is at all feasible, performance is observed or monitored during the tests. However, in

some cases it is sufficient to check before and after subjection to the environment in order to show lack of permanent degradation or malfunction from the tests. Satisfactory operation criteria are determined by the engineering design groups.

While the vibration and centrifuge tests are of a somewhat routine nature, the temperature cycling and absorptivity—emissivity ( $a/e$ ) tests deserve more mention. Absorptivity-emissivity is the ratio of absorptivity of solar energy to the emissivity in the infra-red of the satellite coatings. It is particularly significant in satellites, as the  $a/e$  value determines the temperature limits and cycle characteristics to which the instrumentation is subjected. Restricting the temperature extremes is essential to insure proper power supply performance and to minimize transmitter frequency drifts. The tests are conducted in a vacuum chamber whose dimensions are sufficient to allow installation of the satellite on a stand which permits satellite rotation. Temperature limits of the satellite are controlled by incandescent lights turned on and off in a pre-set program. The chamber walls are cooled to  $-100^{\circ}\text{F}$  by freon to simulate outer space radiation losses. The tests are conducted under a vacuum of  $2 \times 10^{-5}$  mm mercury so that radiative and convective heat transfer in orbit can be realistically simulated, an important requirement for achievement of accurate thermal gradients and  $a/e$  data. The  $a/e$  measurements require a solar spectrum source or its simulation such as carbon arc lights rather than the incandescent lamps mentioned above.

### Operational System

The results obtained to date from telemetering and navigational computations show good correlation between predicted and actual performance and we are able to look forward to the operational system with optimism. The operational system will consist of a family of satellites and stations at altitudes and positions optimum for tracking. The type of signals providing Doppler data will remain as in the Transit 1-B and 2-A, except that in the operational system an injection station will transmit back to the satellite its orbital parameters for a minimum of one day in the future. Thereafter, until new orbital data are injected, the satellite orbits around the earth transmitting on very stable, harmonically related frequencies. Thus, navigators need only use special receiving equipment to obtain their positions from the satellite. The navigational fix can be made in any weather, and there is no need for the ship or station to interrogate the satellite.

Operational satellites will weigh 50 to 100 pounds and have a useful life of several years. They will also contain a miniaturized digital memory for storing orbital information received from the injection station plus a modulator for pulse-modulating this information on the transmitted frequencies for retransmittal to the navigating stations.

### Acknowledgements:

Much of the above information particularly that concerning the basic concepts and design was extracted from the following papers whose authors are all associated with the Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland:

*A Broad-Band Spherical Antenna*—Henry B. Riblet—*Proceedings of the IRE*, April 1960

*A Satellite Doppler Navigation System*—W. H. Guier and G. C. Weiffenbach—*Proceedings of the IRE*, April 1960

*Evolution and Testing of a Navigational Satellite*, CM-972, M. A. Schreiber and T. Wyatt

## Lithocom

(Continued from page 45)

side the earth and the use of a zone, or stratum, of the earth which has suitable electrical properties.

Natural electrical noise at frequencies into the very high frequency range originates mainly in lightning discharges and is propagated from a storm area to other areas just as any radio signal is transmitted. Like useful radio waves, this noise does not penetrate very deep into the earth. Deep in the earth's crust, the noise levels therefore can be assumed to be very low except for the extremely low frequency portion of the spectrum.

By virtue of the shielding effect of the earth, substrata circuits are also well protected against other sources of interference such as man-made electrical noise and deliberate jamming.

The locale of the DECO substrata tests in the Carlsbad area of New Mexico was selected for several reasons: the existence of a thick and rather extensive layer of low conductivity material—very dry sodium chloride or ordinary salt; the presence of thick overburden of reasonably good conductivity material to provide a shield against noise sources; and, ease of access to the strata.

The existence of operating mines in a desirable stratum providing relatively inexpensive and easy access to the chosen medium also influenced the selection of the Carlsbad area for the tests. Soils vary a hundred-to-one in conductivity. DECO's research indicates that Precambrian formations may be considered ideal for optimum results. The choice of Carlsbad was made only after very careful study and analysis by DECO's geologist and radio engineers and the development of satisfactory techniques for probing promising areas.

Other areas with underlying stratum of suitable characteristics are equally useful for this transmission mode. In the absence of an existing mine the desired stratum may be readily entered by a well-drilling operation and by the insertion of a suitable probe for radiating energy into the medium or collecting signals from it.

The present test medium—salt—is only one of several promising propagation media which are found underlying numerous very large areas of the United States.

DECO is currently directing a major effort in the area of hardened communications systems.

## Pacific Scatter System

(Continued from page 29)

also in operation continuously. Sensitive "fail-safe" devices automatically switch between regular and stand-by equipment. This 100% back-up of all essential equipment greatly minimizes any possibility of human error.

But humans play an important part in the operation and maintenance of the advance-design system. Meters must be watched regularly, logs must be kept continuously, and maintenance personnel must be on hand to answer any alarms indicating operating difficulties at any station.

Basic equipment of each ionoscatter station includes duplicate fixed-frequency high-power transmitters, stacked or "piggy-back" types of VHF corner-reflector antennas, four highly sensitive dual-band receivers, and automatic switching facilities.

For teleprinter operation, modulation of transmitters is provided by FSK (frequency-shift-keying). Narrow-band FM is used for the voice channel. Simultaneous operation of multiplexed teleprinter and voice channels is accomplished by use of frequency separation within the assigned frequency band.

Telegraph multiplexing equipment supplies 16 duplex circuits, each with a 60 to 100 word-per-minute capacity. All teleprinter circuits operate at the same rate. Multiplexing equipment utilizes modular plug-in packaging, which permits rapid isolation and repair of malfunctioning elements. Transistorized magnetic storage, shift, and readout circuits are used throughout, operating at low power and low heat levels to maximize reliability. Timing circuits are derived from master oscillators with extremely high stability.

Each station has a central monitor and supervisory console equipped with indicators, meters, and recorders that collectively and continuously show the operating status of all primary and alternate equipment.

The voice order-wire circuit that spans the system is on a selective-dialing party-line basis.

Communication centers at Midway, Wake, Guam, and Luzon are linked to stations of the system by conventional, modern radio and cable facilities.

The Pacific Scatter Communication System was designed, developed, and constructed for the U. S. Army Signal Corps by Page Communications Engineers, Inc., a subsidiary of Northrop Corporation. Technical assistance in the operation and maintenance of most of the stations is also being supplied by Page.

## BMEWS Structures

(Continued from page 28)

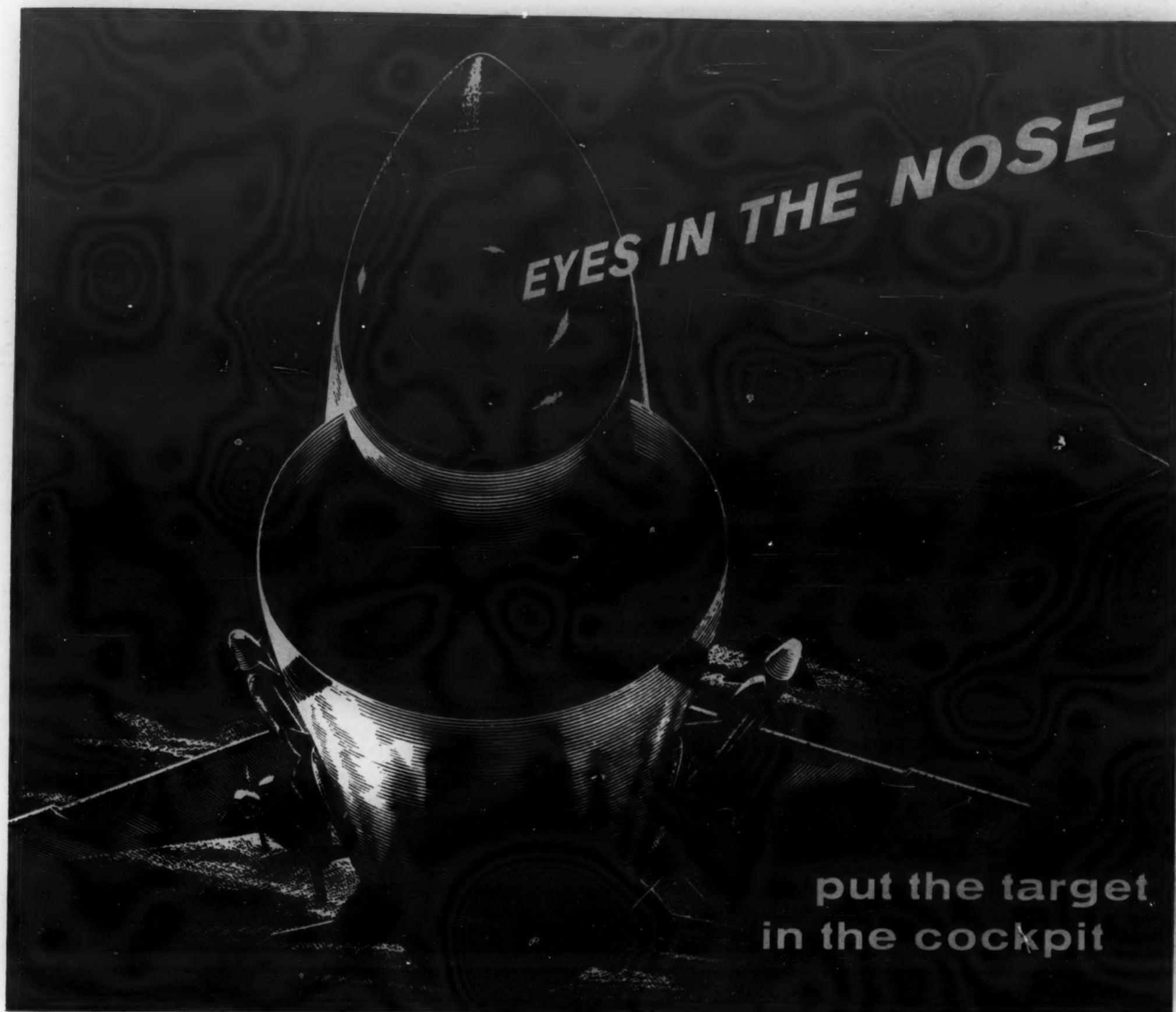
the severe logistics problem. Therefore, in order to expedite the testing as much as possible and to locate any faults that the contractor could correct during construction, a series of exploratory tests were performed. These tests proved that an area of sixteen feet (six panels) could usually be tested if a similar completed area existed on each side and the roof. During these tests it was necessary that welding operations and the operation of power tools in the immediate vicinity be halted. The results of these tests were not considered final but certainly pointed out serious deficiencies which could not always be visually detected. This procedure was emphasized in areas near structural members, eaves, and other similar areas which were difficult to weld and inspect either visually or by X-ray.

### Final Tests

The evaluation is still continuing as of this writing and will be carried on during the severe winter with its attendant storms and high velocity winds. The final tests when the buildings are completed will be performed using a transmitter of a recently developed radar set as a "noise source." The antenna will be beamed at each side and roof of each building. While this procedure is not required by the MIL Standard, it will provide a double check on the effectiveness of the visual inspection and of the tests conducted to date and will more closely duplicate actual operating conditions. It is expected that few deficiencies will be found. The visual inspection has been very thorough and the test results to date indicate that this "super-screen room" will meet the specification requirements with comparative ease.

As a result of this task the Engineering Sciences Department of USA-SRDL has obtained invaluable information in the design, construction, and testing techniques of large shielded buildings. As the need for such buildings is rapidly increasing in areas of high power microwave radiation and missile testing, and little data has been available to date, it is believed that this information will be of considerable assistance to the Department of Defense and their contractors in future work of this type.

Reference: "Proposed Testing and Inspection of Shielded Structures," dated 20 Feb 59 prepared by Metcalf & Eddy, Boston, Mass.

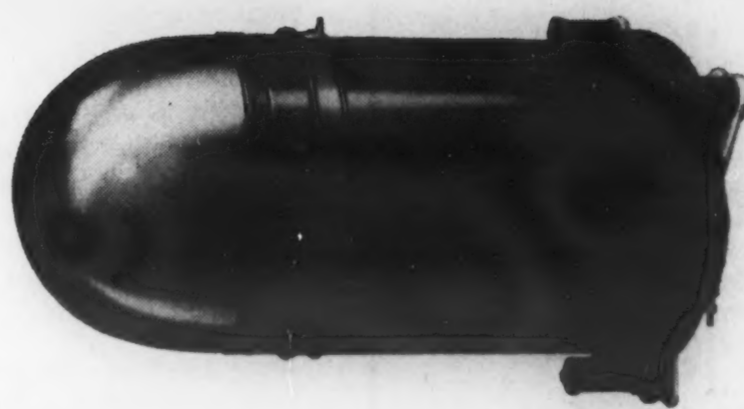


As a result of development by the Magnavox Company in conjunction with the Navy Department, every Chance Vought F8U-2N Crusader Fighter Pilot sees the target at a glance—day or night, in any kind of weather.

Here are the eyes of a modern weapons system . . . a component that delivers the range, weight and reliability so absolutely necessary to successful tactical operations.

This airborne radar system is just one of many systems which have been and are being designed and produced to satisfy the tactical requirements of the military services in the fields of Communications, Airborne Radar, ASW, Navigation, Fusing and Data Handling.

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1962

Theodore L. Bartlett  
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The President, the immediate Past President, the Vice Presidents and the Counsel are ex-officio members of the Board of Directors.

\*Executive Committee Member.

## Association affairs



W. J. Baird, AFCEA General Manager, is shown presenting a framed letter from President Eisenhower to B. H. Oliver, Jr., AFCEA National President written on the occasion of the AFCEA 14th Annual Convention. Pictured from left to right are: Major General Harold W. Grant, USAF, Director, Communications-Electronics; Major General Earle F. Cook, USA, Deputy Chief Signal Officer; Mr. Oliver; Rear Admiral Frank Virden, USN, Assistant Chief of Naval Operations (Communications)/Director, Naval Communications; Col. Baird; Rear Admiral William Irvin, Chief, Defense Communications Agency.



AFCEA National President Benjamin H. Oliver, Jr., presents a life member certificate to Rear Admiral William Irvin, honoring his recent appointment as first Chief of the Defense Communications Agency. Pictured from left to right are: Keith B. Lewis, president, AFCEA Washington chapter; Major General Harold W. Grant, USAF, Director, Communications-Electronics; Mr. Oliver; Major General Earle F. Cook, USA, Deputy Chief Signal Officer; Admiral Irvin; Rear Admiral Frank Virden, USN, Assistant Chief of Naval Operations (Communications)/Director, Naval Communications.

### Admiral Irvin Honored at Luncheon

A luncheon was held August 3, at the Army-Navy Town Club, Washington, D. C. honoring Rear Admiral William Irvin. He has been appointed the first Chief of the Defense Communications Agency (DCA) by Secretary of Defense Thomas S. Gates, Jr. Admiral Irvin first became an AFCEA honorary life member in 1957. Before the luncheon he was presented with a new life member certificate indicating his new position.

Those attending the luncheon were:

Benjamin H. Oliver, Jr., AFCEA National President; Major General Harold W. Grant, USAF, Director, Communications-Electronics; Rear Admiral Frank Virden, USN, Assistant Chief of Naval Operations (Communications)/Director, Naval Communications; Major General Earle F. Cook, USA, Deputy Chief Signal Officer; Keith B. Lewis, Manager, Washington office, Eastman Kodak Company and President, AFCEA Washington chapter; Lester Carr, President, Developmental Engineering Corp.; W. J. Baird, General Manager, AFCEA.

### **Fifty-Third Chapter Approved**

A new chapter at Lawton-Fort Sill, Oklahoma, making it the 53rd in the Association, has been approved by National Headquarters as of August 1. Temporary officers are: president, Colonel Rudolph Laskowsky; 1st vice president, Lieutenant Colonel Laurence W. Ash; 2nd vice president, William J. Utterback; secretary, Charles E. Warner; treasurer, Charles J. Cremeen.

### **Plans for Executive Committee Meeting**

The Executive Committee of the Association will meet September 28, at the Hughes Aircraft Company office in Washington, D. C. In addition to a final report on the 1960 Annual Convention, the order of business will include among other items, the 1961 Budget, plans for the 1961 Convention, a report on SIGNAL Magazine and 1961 special issues, membership and chapter affairs and plans for celebrating the 15th Anniversary of the founding of AFCEA.

### **AFCEA Celebrates 15th Anniversary**

The anniversary of fifteen years of service to the armed forces and industry by the Armed Forces Communications and Electronics Association will be celebrated in 1961. During these years the Association has progressed to the point where it now occupies an important position in the fields of communications, electronics and photography.

Fifteen years ago Major General H. C. Ingles, World War II Chief Signal Officer, realized the need for close cooperation between the military and industry and along with other leaders organized the Army Signal Association. In 1947, at the time of the unification of the Services, the name was changed to the Armed Forces Communications Association. The name was again changed in the fall of 1954 to the Armed Forces Communications and Electronics Association. This final change was made in keeping with the rapid growth of the electronics field.

The Association magazine, SIGNAL, was first published in September 1946.

During its history the Association has been honored in having the guidance and dedicated efforts of the following outstanding Association presidents: 1946-1949, David Sarnoff, chairman of the board, Radio Corporation of America; 1949-1950, Frederick R. Lack, retired vice president and director of Western Electric Company; 1950-1951, Theodore S. Gary, vice president, General Telephone and Electronics Corporation; 1951-1952, William J. Halligan, founder and chairman of the board of Hallicrafters Company; 1952-1953, W. Walter Watts, group executive vice president, Radio Corporation of America; 1953-1954, Joseph R. Redman, former Director of Naval Communications and now a communications consultant to Western Union Telegraph Company; 1954-1956, George W.

Bailey, former president of the American Radio Relay League and of the International Radio Union, now executive secretary of the Institute of Radio Engineers; 1956-1957, Percy G. Black, vice president, General Telephone Service Company; 1957-1959, Frederick R. Furth, former chief, Office of Naval Research, now vice president of International Telephone and Telegraph Corporation. Benjamin H. Oliver, Jr., vice president, Upstate, New York Telephone Company, is now serving his second term as president of the Association.

The Executive Committee meeting to be held this month will consider an appropriate celebration for this fifteenth anniversary.

### **Charter Presentation in Okinawa**

Presentation of the Okinawa chapter charter was made by Henry T. Killingsworth, vice president, American Telephone and Telegraph Company on July 7. Mr. Killingsworth spoke to the Hawaii chapter in Honolulu on July 13. A report of this meeting and a summary of his speech, "Trans-Pacific Cable Systems," are contained in Chapter News on page 58.

### **Western Electric New Sustaining Member**

The Western Electric Company, Inc. has become a sustaining member of the Association. A manufacturing and supply unit of the Bell System, the company has been a group member. C. Raymond Smith, vice president, will act as company representative.

Those named to membership in the Association are: H. I. Romnes, president; C. Raymond Smith, vice president; Joseph R. Bransford, vice president; Timothy E. Shea, vice president; J. Harold Moore, General Mgr., Defense Projects; A. Pope Lancaster, vice president; Frederick E. Henderson, assistant vice president, Radio Division; William H. Doherty, manager, Government Sales, Radio Division; Jack R. Whitney, manager, Government-Industry Relations, Radio Division; Millard C. Richmond, Washington Representative, Radio Division; Henry N. Willets, manager, Government Communications Sales, Radio Division; Thomas L. DeNyse, superintendent, Contracting and Sales, Defense Projects Division; Pierce M. Maher, assistant manager, Government Sales, Radio Division; Gerald A. Murray, assistant manager, Government Communications Sales, Radio Division; Karl F. Krug, assistant manager, Government Communications Sales, Radio Division; Harry A. Pawell, Western Distribution manager, Telephone Sales Division; John A. Bowman, project manager, Defense Projects Division; David Younger, assistant project manager, Defense Projects Division; Henry H. Coords, assistant project manager, Defense Projects Division; Rodney M. Goetchi, manager project services, Defense Projects Division; Otto R. Richter, assistant project manager; Defense Projects; S. Kingsley Shull, as-

stant project manager, Defense Projects Division; Robert P. Wilson, manager, Government Equipment Sales, Radio Division; Daniel K. Chinlund, assistant project manager, Defense Projects Division; John W. Darcy, comptroller, Defense Projects Division; Herbert K. Disbrow; assistant superintendent, Defense Projects Division; William A. Balley, assistant superintendent, Labor Relations, Baltimore Works; Virgil L. Schad, Jr., assistant superintendent, Works Maintenance, Baltimore Works; Edward A. Zneimer, staff assistant, Radio Division.

### **Northrop Corp. New Group Member**

The Northrop Corporation of California, manufacturers of weapons systems, is a new group member. Those designated to represent the company are: Corporate Offices, Norman Warren, director, Public Relations and Advertising; H. E. Maninger, Corporate Development Planner; Norair Division, R. G. Longaker, chief, Ground Environment and Support Systems; F. L. Lyons, chief, Support Engineering Group; Nortronics Division, J. F. Lynch, engineering specialist, Electronic Systems & Equipment Department; Lauren Persons, group supervisor, Production Engineering, Systems Support Department; Radioplane Division, D. K. Welch, Engineering Department Branch Engineer; W. C. Armstrong, Engineering Department Branch Engineer.

### **In Memoriam**

AFCEA National Headquarters was sorry to hear of the passing of two of its outstanding members.

Captain Thomas H. Templeton, a senior executive engineer in the engineering research division of Stanford Research Institute, Menlo Park, California, died recently. He had been a supporter of AFCEA for many years and had served with distinction on the board of directors of the San Francisco chapter.

He was a graduate of the U. S. Naval Academy and Columbia University and served in the Pacific during World War II.

Dr. John T. Bolljahn, executive vice president of Granger Associates died June 25, in Palo Alto, California. Prior to joining Granger, he was assistant director of engineering research at Stanford Research Institute, Menlo Park, California, where he did research on antennas, propagation, microwave improvement, aircraft communication and navigation, weapon and missile tracking systems.

AFCEA extends sympathy to the members of each family.

## NEW MEMBERS

Listed below are new members of the AFCEA who have joined the Association during the month of July. Members are listed under the chapter with which they are affiliated.

### Arizona

C. Richard Gartman

### Atlanta

Arnold Pearson  
Hoyt E. White  
James G. Shurbutt  
Carl C. Brigham  
Donald L. Tibbitts  
Roderick F. O'Connor  
William E. Reiser  
R. G. Embry  
John R. Montgomery

### Augusta-Ft. Gordon

William H. Connell

### Baltimore

William A. Balley  
Virgil L. Schad, Jr.

### Boston

Fred S. Kerr  
Julian V. Willemin  
Harry W. Persson

### Chicago

Joseph J. Modiz  
Richard R. Cook  
S. R. Collis  
Henry J. Sloboda

### Dayton-Wright

Wayne W. Anderson  
James Anthony Metzger

### Decatur

Robert R. Lewter  
Lt. Cdr. Charles S. Thrope  
Ralph S. Grist

### Ft. Monmouth

Robert L. Layburn  
Howard E. Miller  
Francis E. Daigler  
Howard M. Wittner  
Stanley R. Sadin  
Albert T. Christensen  
Lt. Col. Howard M. Russell

### Greater Los Angeles

Richard R. Stoddart  
Fred F. Hasenstab  
Norman Warren  
H. E. Manning  
R. G. Longaker  
F. L. Lyons  
J. F. Lynch  
Lauren Persons  
D. K. Welch  
W. C. Armstrong  
Dan Peterson  
Brookman R. Painter  
S. A. Lask  
Robert A. Belmont

### Gulf Coast

James I. Ward  
Capt. Edward D. Rodgers, Jr.

### Hawaii

Richard Severson  
Charles N. Arnold  
Lt. Col. George A. Kurkjian  
Eugene J. Rice  
Robert W. Wild  
Maj. Andrew R. Porreco  
Capt. Donald B. McBride  
Lt. Calvin M. Weil  
Gene Piety

### Kansas City

Arthur Goldsmith

### Louisiana

William A. Buchanan

### New York

Don Karshan  
Robert J. Rosan  
W. C. King  
Francis J. Kane  
William C. Daviet  
Edward F. Sanger  
Herbert K. Disbrow  
Edward A. Zneimer

### North Carolina

Lt. Col. William M. Hamilton  
Marion O. Wells  
Lt. Col. James W. Powers

### North Texas

Carlow L. Dodd

### Northwest Florida

Richard P. Costello  
Albert J. Ordonez

### Okinawa

Capt. Julian L. Klein  
Oran E. Kelley  
Capt. Walter O. Reil

### Paris

Lt. Col. William R. Blake

### Philadelphia

William Altier

### Pittsburgh

Herman Barnett

### Rome-Utica

Bernard R. Brabant

### San Francisco

Paul C. Carman  
Ira B. Cave

### San Juan

John A. Schwartz  
Leslie E. James  
Windsor Miles  
Capt. John Henry  
Joseph H. Nagi, Jr.  
A. Delos Santos  
Carlos Albiau Miranda  
Edward N. Group Von Graupen

### Santa Barbara

Olen L. Shaver  
Milton S. Roth

### Scott-St. Louis

James F. Bowen  
Gene E. Nichols

### South Carolina

Capt. Charles D. Hood  
R. W. Jordan

### South Texas

Francis B. Murray

### Tinker-Oklahoma City

Lynn E. Whitaker

### Tokyo

Tome E. Brown

### Washington

John T. Harris  
John F. Vredenburg  
Charles K. Osborne  
Willie R. Knight  
Ellen J. Beckman  
Herbert H. Schenck  
Edgar H. Hamilton  
Joseph S. Ives  
Harold E. Dinger  
Harry Mottek  
George J. Largess  
Col. Giles L. Evans, Jr.  
Michael S. Balbes

### White Sands Missile Range

Warren F. Ratliff  
Ellis H. Nolte  
John H. Sandoz  
Willis S. Parsons  
John L. Bryce  
Burton W. Reed  
Donald H. Rowland  
Tilford L. Ferguson  
William H. Fickes  
Capt. Lewis R. Nenkirck  
Roy C. Durbon  
SFC Jerome Ellman  
Kristian H. Brandt  
Donald H. Rudd  
Louis C. Sample

James K. Fawcett  
Edward H. Howe  
Inium P. Glipa  
Claremont D. Fritsche  
Nelson S. Fox  
SP-5 Robert Y. Izumihara  
Hollis G. Hungate  
Royce B. Lewis  
Harold A. Lambeth  
Charles M. Johnson  
Lyle D. Booney  
Michael E. Brady  
Douglas E. Stolberg  
Frank J. Schlueter  
M-Sgt. George D. Sigmond  
Harold A. Smith  
Walter L. Bogart  
Harry F. Bennett  
William M. Balentine, Jr.  
Elbert G. Barrett  
Mead S. Arbogast  
Antone Azevedo  
Thomas E. Allen  
Paul W. Albert  
Carroll L. Wright  
SFC-E-7 Vincent D. Vaillancourt

M-Sgt. Welton W. Watson  
Luther Weir  
Maj. Paul I. Wells  
Forest C. Welsh  
Jack White  
Capt. William R. White  
Robert T. Williams  
Sgt. William K. Wilson  
Capt. Drew Dowling  
Ralph H. Work  
Clarence M. Decker  
SFC Cantrell M. Daniel  
Monrol A. Curtis  
James W. Caviness, Jr.  
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Luis Bustillos, Jr.  
Richard P. Bursaw  
Claude P. Malone  
Thomas F. Marsh  
Earl J. Martell  
Ronald E. Mitchell  
Wade C. McClellan  
Maj. Haldon D. Brown  
Marvin R. Pearson  
Charles E. O'Meara  
John L. Oliver  
E-7 Salvatore  
SFC Carl Maag  
Charles A. Painter, Jr.  
Joseph B. Lykins  
James W. Lowman  
Chester Welch  
Scott D. Cozby

### Members at Large

Capt. Sterling M. Rodgers  
Elmer L. Surdam  
Maj. George A. Miner  
Edward V. Pelissier  
2nd Lt. Wallace P. Mack, III



**AN ACHIEVEMENT IN DEFENSE ELECTRONICS**

## **AN/FSA-12--First to detect and process 3-D radar data automatically**

The first equipment to successfully automate the processing of three-dimensional data direct from a working radar, the AN/FSA-12 (XW-1) has operated since 1958. This detector tracker has enabled General Electric to develop many improved radar techniques and equipment.

New concepts in correlation and smoothing in the track-while-scan method have been demonstrated. Delay lines applied to digital techniques

and plug-in wiring boards have been improved. New ideas in data storage and digital circuitry have been applied.

This experimental model continues to be a proving ground in research and development of advanced military electronics. A completely solid state production version of the AN/FSA-12 will soon be available for many of our nation's air defense radar sites. 176-04

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HEAVY MILITARY ELECTRONICS DEPARTMENT • SYRACUSE, NEW YORK

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# AFCEA Sustaining and Group Members

## Communications—Electronics—Photography

Listed below are the firms who are sustaining and group members of the Armed Forces Communications and Electronics Association. By their membership they indicate their readiness for their share in industry's part in national security. Each firm nominates several of its key employees or officials for individual membership in AFCEA, thus forming a group of the highest trained men in the electronics and photographic fields, available for advice and assistance to the armed services on research, development, manufacturing, procurement, and operation.

### Sustaining Members

American Telephone & Telegraph Co., Long Lines Department  
Cook Electric Co.  
General Electric Co., Defense Electronics Div.  
International Telephone & Telegraph Corp.  
New York Telephone Co.  
Western Electric Co., Inc.

### Group Members

Adler Electronics, Inc.  
Admiral Corp.  
Allied Control Co., Inc.  
Allied Radio Corp.  
American Cable & Radio Corp.  
American Institute of Electrical Engineers  
American Machine & Foundry Co.  
American Radio Relay League  
American Telephone & Telegraph Co.  
Amphenol/Borg Electronics Corp.  
Anaconda Wire & Cable Co.  
Andrew Corp.  
Arnold Engineering Co.  
Associated Electrical Industries Ltd.  
Atlas Precision Products Co.  
Automatic Electric Co.  
Automatic Electric Sales Corp.  
Automatic Telephone & Electric Co., Ltd.  
Autonetics, Division of North American Aviation, Inc.  
Barry Controls, Inc.  
Bell Telephone Company of Pa.  
Bell Telephone Laboratories, Inc.  
Bendix Radio Division, Bendix Corp.  
Bendix Systems Division, Bendix Corp.  
Bliley Electric Co.  
British Thomson-Houston Co., Ltd.  
Bruno-New York Industries Corp.  
Budd Electronics, Inc.  
Burroughs Corp.  
California Water & Telephone Co.  
Cambridge Thermionic Corp.  
Capitol Radio Engineering Institute, Inc.  
Carolina Telephone & Telegraph Co.  
Central Technical Institute  
Chesapeake & Potomac Tel. Co.  
Cincinnati & Suburban Bell Tel. Co.  
Collins Radio Co.  
Columbia Broadcasting System, Inc.  
Contraves Italiana  
Convair, Division of General Dynamics Corp.  
William C. Copp & Associates  
Copperweld Steel Co.  
Cornell-Dubilier Electric Corp.  
A. C. Cossor Ltd.  
Craig Systems, Inc.  
Crosley Division-Avco Corp.  
Decca Navigator Co. Ltd.  
Designers For Industry, Inc.  
Developmental Engineering Corp.  
Diamond State Telephone Co.

Dictaphone Corp.  
DuKane Corp.  
Du Mont, Allen B., Laboratories, Inc.  
Eastman Kodak Co.  
Electronic Associates, Inc.  
Electronic Communications, Inc.  
Elgin Metalformers Corp.  
Fairchild Camera & Instrument Corp.  
General Analysis Corp.  
General Aniline & Film Corp.  
General Telephone & Electronics Corp.  
Gilfillan Bros., Inc.  
Gray Manufacturing Co.  
Hallamore Electronics Co.  
Hallcrafters Co., The  
Haloid Xerox Inc.  
Hazeltine Electronics Division, Hazeltine Corp.  
Heinemann Electric Co.  
Hoffman Electronics Corp., Military Products Div.  
Hughes Aircraft Co.  
Illinois Bell Telephone Co.  
Indiana Bell Telephone Co.  
Indiana Steel & Wire Co.  
Institute of Radio Engineers  
Instruments for Industry, Inc.  
International Business Machines  
International Resistance Co.  
Jansky & Bailey, Inc.  
Jerrold Electronics Corp.  
Kleinschmidt Laboratories, Inc.  
Leich Sales Corp.  
Lenkurt Electric Co.  
Ling-Altec Electronics, Inc.  
Litton Industries, Inc.  
Lockheed Aircraft Corporation  
Loral Electronics Corp.  
Machlett Laboratories, Inc.  
Magnavox Co.  
Marconi's Wireless Telegraph Co. Ltd.  
Martin Co., The  
Materiel Telephonique Co.  
McCoy Electronics Co.  
Melpar, Inc.  
Michigan Bell Telephone Co.  
Montgomery Co., The  
Motorola Inc.  
Mountain States Telephone & Telegraph Co.  
Mullard Ltd.  
Muter Co., Rola & Jensen Divisions  
Mycalex Corporation of America  
National Co., Inc.  
Nems-Clarke Co., Div. of Vitro Corp. of America  
New England Tel. & Tel. Co.  
New Jersey Bell Telephone Co.  
North Electric Co.  
Northrop Corp.  
Northwestern Bell Telephone Co.  
Oak Manufacturing Co.  
Ohio Bell Telephone Co.  
Pacific Telephone & Telegraph Co.  
Packard-Bell Electronics Corp.  
Page Communications Engineers, Inc.  
Phelps Dodge Copper Products Corp.  
Philco Corp.

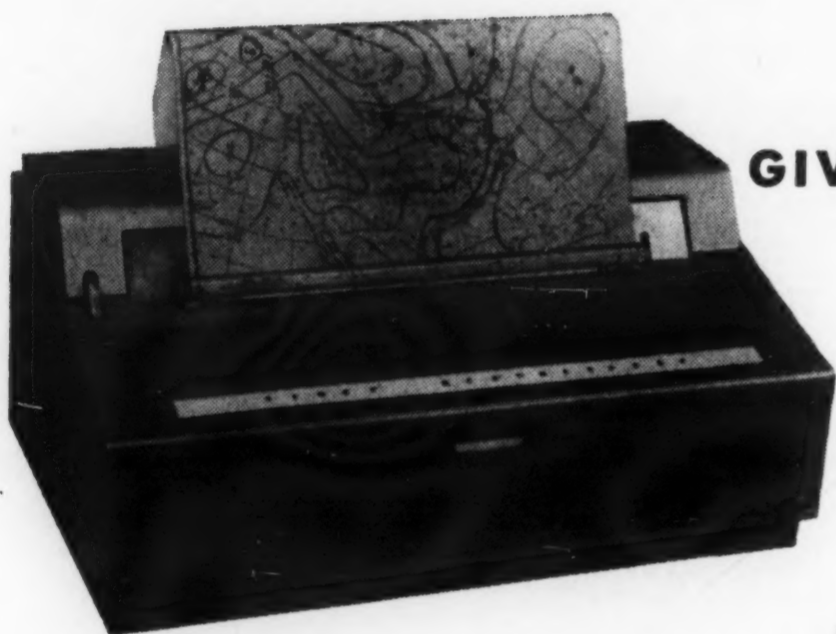
Photographic Society of America  
Plessey Co., Ltd.  
Prodelin Inc.  
Radiation Inc.  
Radio Corporation of America  
Radio Corporation of America, Astro-Electronics Products Div.  
Radio Corporation of America, Defense Electronics Products  
RCA Great Britain, Ltd.  
Radio Engineering Laboratories, Inc.  
Radio Frequency Laboratories, Inc.  
Raytheon Co.  
Red Bank Division, Bendix Corp.  
Reeves Instrument Corp.  
Republic Aviation Corp.  
Rixon Electronics, Inc.  
Rocke International Corp.  
Ryan Aeronautical Co.  
Saxonburg Ceramics, Inc.  
Scanner Corporation of America, Inc.  
Singer Manufacturing Co., The Military Products Division  
Smith-Corona Marchant Inc., Research and Development Division  
Society of Motion Picture & Television Engineers  
Southern Bell Telephone & Telegraph Co.  
Southern New England Telephone Co.  
Southwestern Bell Telephone Co.  
Sperry Gyroscope Co., Division of Sperry Rand Corp.  
Sprague Electric Co.  
Stackpole Carbon Co.  
Standard Electronics Co.  
Standard Telephones & Cables, Ltd.  
Stanford Research Institute  
Stewart-Warner Corp.  
Stromberg-Carlson Co., Division of General Dynamics Corp.  
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Telectro Industries Corp.  
Tele-Dynamics Div., American Bosch Arma Corp.  
Telephonics Corp.  
Teleprinter Corp.  
Teletype Corp.  
Texas Instruments Incorporated  
T.M.C. (Canada) Ltd.  
Tung-Sol Electric, Inc.  
Union Carbide Corp.  
United Telephone Co.  
United Transformer Co.  
Varian Associates  
Waterman Products Co., Inc.  
Webcor, Inc., Government Division  
West Coast Telephone Co.  
Western Union Telegraph Co.  
Westinghouse Electric Corp.  
Westrex Corp., a Division of Litton Industries, Inc.  
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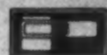
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# Chapter News

## Cape Canaveral

At the meeting held July 14 at the Officers Club, Patrick Air Force Base, members elected officers for this year. Other business was appointment of committees and discussion of the schedule for the remainder of the year.

Those elected to serve as officers were: president, Lieutenant Colonel James W. Kelly, USAF; first vice president, Dan W. Cusic; second vice president, Captain Clarence W. Goldey, USA; secretary, Howard F. Blackwood; treasurer, Edward A. McCarthy; directors, Arthur R. Beach, H. Benner Hooper, Joseph A. Kozusko, J. Roy Totty.

Campbell Steward, special assistant to the general manager, AFCEA, met Captain Goldey, second vice president of the chapter, at a test launching of a U. S. Army PERSHING tactical-range missile at the Atlantic Missile Range on July 26, and they discussed local chapter affairs.

## Chicago

A special meeting celebrating the 100th Anniversary of the Army Signal Corps was held by the chapter on June 23. The chapter members, Colonel Carl A. Cuphaver, commanding officer, Midwest Regional Office, U. S. Army Signal Supply Agency, Chicago, and Colonel James H. Fulton, Fifth U. S. Army Signal Officer, were joint hosts to military leaders and top executives of industry and commerce throughout the Chicago area.

Major General Herbert L. Scofield, chief, Procurement and Distribution Division, Office of the Chief Signal Officer, Department of the Army, Washington, D. C. was guest speaker. He reviewed the century of progress in Signal Corps communications, from the smoke signals used on the western plains 100 years ago to America's recent satellite, TIROS I of 1960, which was instrumented by the U. S. Army Signal Corps. A team of seven selected soldiers from the Corps dressed in uniforms of various periods of American history participated.

During the business meeting officers and board members for the coming year were elected. William L. McGuire, vice president and general commercial manager, Automatic Electric Company, was re-elected for a second term as president. Also re-elected as vice presidents were: Arthur J. Schmitt, Amphenol-Borg Electronics Corporation; Carrington H. Stone, Carrington H. Stone Engineers & Exporters; James F. Weldon, Midwest Regional Office, U. S. Army Signal Supply Agency. New vice presidents are Harry Bendtsen, Paraplegics Manufacturing Company, and Walter H. Flinn, Illinois Bell Telephone Company. Sanford H. Levey, Allied Radio Corporation, was

elected to a second term as secretary-treasurer.

Elected to the board of directors were: Colonel Turner Wright Gilman, Midwest Regional Officer, U. S. Army Signal Corps; Raymond K. Fried, Feinberg & Fried; Captain Robert H. Northwood, Electronic Supply Office, Department of Navy; A. P. Lancaster, Western Electric Company; Thomas J. Lloyd, Admiral Corporation; Colonel James H. Fulton, Signal Officer, Fifth U. S. Army; Lieutenant Colonel Carl E. Trexler, Air Research and Development Command, U. S. Air Force; Walter Pagenkopf, Teletype Corporation, Irving Koss, Motorola; Richard Morey, Morey & Company; Henry J. McDonald, Kellogg Switchboard & Supply Company; L. A. Pereira, L. A. Pereira & Company; Colonel James R. Ourand, Chicago Air Procurement Division, U. S. Air Force.

## Dayton-Wright

On July 7, at the Officers Club, Dayton Air Force Depot, the chapter met for the installation of officers.

Elected to serve for the coming year are: president, Colonel Robert L. Salzarulo, director of Procurement and Production, DAFD; executive vice president, Allan F. Schmahl, manager, Customers Relations, Central Region, Sylvania Electronics Systems Division; secretary-treasurer, K. C. McClellan, Hoffman Laboratories. The six vice presidents are: Colonel W. S. Heavner, chief, Reconnaissance Lab., WADD; E. C. Hill, sales manager, Light Military Electronics Department, General Electric; Colonel Herbert E. Johnson, Jr., chief, Maintenance Systems Division, AMC; Lieutenant Colonel K. J. Schloss, chief, Electronics Technology Lab, WADD; Richard P. Turner, manager, Hoffman Laboratories; Ruby F. Brothers, Information Officer, DAFD.

## Hawaii

H. T. Killingsworth, vice president, American Telephone and Telegraph Company, was guest speaker to members and guests of the chapter at the July 13 meeting at the Hawaiian Village Hotel. He spoke on "Trans-Pacific Cable Systems."

He told of American Telephone and Telegraph's plans for improving existing Pacific service and new cable-laying projects. The three-part program includes: (1) Increasing the capacity of the cable between the Mainland and Hawaii; (2) Participation with the British Commonwealth in a cable route from Vancouver to New Zealand and Australia, through Oahu; (3) The major project, laying a cable westward from Oahu to Japan, in cooperation with Japanese associates.

The chapter has elected new officers. Those to serve for 1960-61 are: presi-

dent, Colonel W. A. Simpson, USA, Hq., USARPAC; first vice president, Captain W. F. Hardman, USN, CINCPAC; second vice president, Colonel James H. Weiner, USAF, PACAF; third vice president, Richard Waterman, Kentron, Hawaii; secretary, Lieutenant Colonel George A. Kurkjian, USARPAC; treasurer, Mrs. Della E. Pennington, Navy, Comm.; national council representative, Robert S. Lowrey, Hawaiian Telephone Company.

## London

Members and guests of the chapter gathered at the Columbia Club, Crystal Ballroom, on June 30 for the annual business meeting. Following dinner, officers for the 1960-61 year were elected.

Those unanimously elected were: president, Lieutenant Colonel W. H. Fritz, USA; vice president, Captain R. Hay, USN; 2nd vice president, Colonel E. C. Weatherly, USAF; 3rd vice president, Lieutenant Colonel John T. Newman, USA; 4th vice president, Harvey Schwartz, 5th vice president, Colonel J. A. Plihal, USAF; associate vice presidents, Sir Harold Bishop, Sir Reginald Payne-Gallwey, BART, Henry Chisholm, Major General E. S. Cole, Royal Signals, Henry G. A. Kay; secretary, Lieutenant Colonel S. B. Hunt, USMC; associate secretary, L. T. Hinton; treasurer, Lieutenant G. P. O'Neill, USAF; associate treasurer, P. D. Canning.

## Louisiana

A dinner meeting was held July 20, at Camp Leroy Johnson, Commissioned Officers Mess at which members elected new officers. There was a guest speaker from the Ampex Corporation of Atlanta, Georgia, who spoke on "Video Tape." Names of the new officers will appear next month.

## Okinawa

The chapter had its charter meeting July 7. Henry T. Killingsworth and Charles Duncan of the American Telephone and Telegraph Corporation and J. Ballard Atherton and Douglas Guild of the Hawaiian Telephone Corporation attended the meeting. Also among the honored guests present were officers of the Ryukyu Telephone and Telegraph Public Corporation.

## San Francisco

The July 21, meeting was held at the Presidio Officers Club, Presidio of San Francisco. Following dinner the Hon. Frank H. Higgins, former Assistant Secretary of the Army, Logistics, addressed the chapter on "World Current Topics." He was introduced by Lieutenant General James D. O'Connell, USA, (Ret.), Chief Signal Officer, (1955-59).

In keeping with the celebration of the 100th Anniversary of the Signal Corps there was an exhibit of some new Army signal equipment, courtesy of Colonel H. L. Davis, Jr., Signal Officer Sixth U. S. Army.

#### Seattle

On March 16, at the Benjamin Franklin Hotel the chapter held a Ladies' Night with a dinner and a special program.

John Haverly, vice president and

radio-TV director, Martin and Tuttle Advertising Agency, and Northwest Representative of Television Communications, Inc., San Francisco, opened the program with a talk on "Video Tape" and its place in our future. He said, "The industry is already forecasting home video recorders on which you can play your own taped shows. It will be possible, too, to record the picture off the tube of your TV set and replay the program whenever you wish."

Another part of the program was a

demonstration of radio frequency cooking by Miss Mary Norris, City Light Home Economist. Miss Norris cooked eggs, bacon, baked apple and gingerbread on a radio-frequency range which was hooked up. With this new concept of cooking the inside of food is cooked as fast as the outside. Water will boil in 4.5 seconds. A magnetron oscillator operating at 2450 megacycles supplies 800 watts of radio-frequency power for cooking. Following the demonstration

(Continued on page 68)

**Chicago**—Major General Herbert L. Scofield, Chief, Procurement and Distribution Division, Office of the Chief Signal Officer, Washington, D. C., is shown cutting the Signal Corps' 100th anniversary birthday cake at the June 23 meeting. To General Scofield's right is Walter H. Pagenkopf, AFCEA regional vice president, and other head table guests.



**Dayton-Wright**—Newly elected officers of the chapter are seated, L to R: Allan F. Schmah, executive vice president; Colonel Robert L. Salzarulo, president; K. C. McClellan, secretary-treasurer; back row, L to R: vice presidents Richard P. Turner, Colonel Herbert E. Johnson, Jr., Ruby Brothers, Colonel W. S. Heaven, Lieutenant Colonel K. J. Schloss. E. C. Hill, vice president, is not pictured.



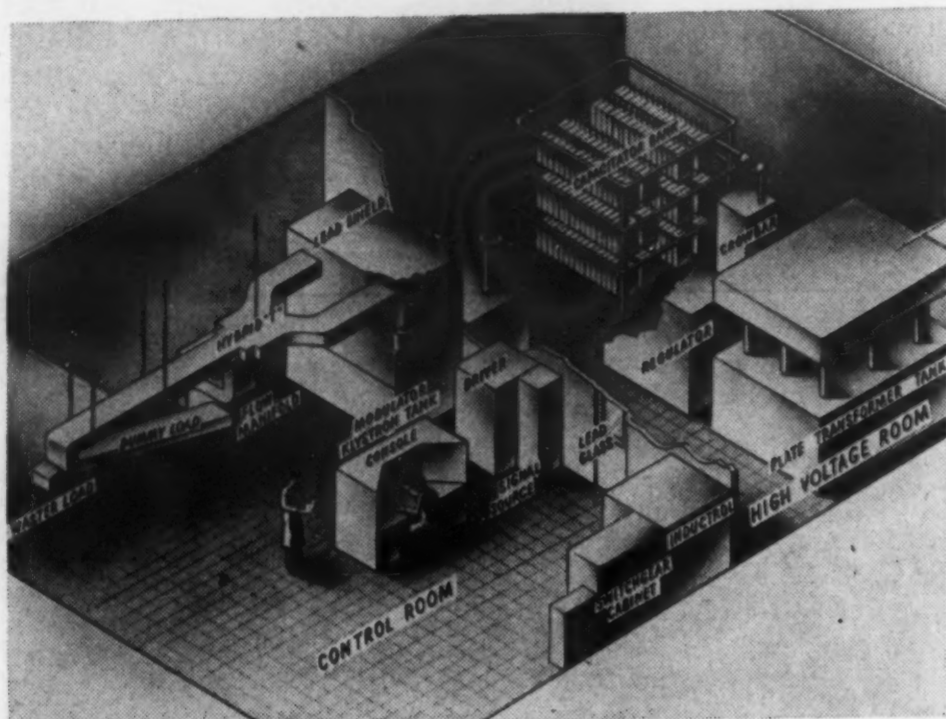
**Hawaii**—Pictured at the July 13 meeting are L to R: J. Ballard Atherton, H. T. Killingsworth, Brigadier General Stuart S. Hoff, Major General Gordon A. Blake, Robert Lowrey, chapter president and Brigadier General Bernard M. Wootton.



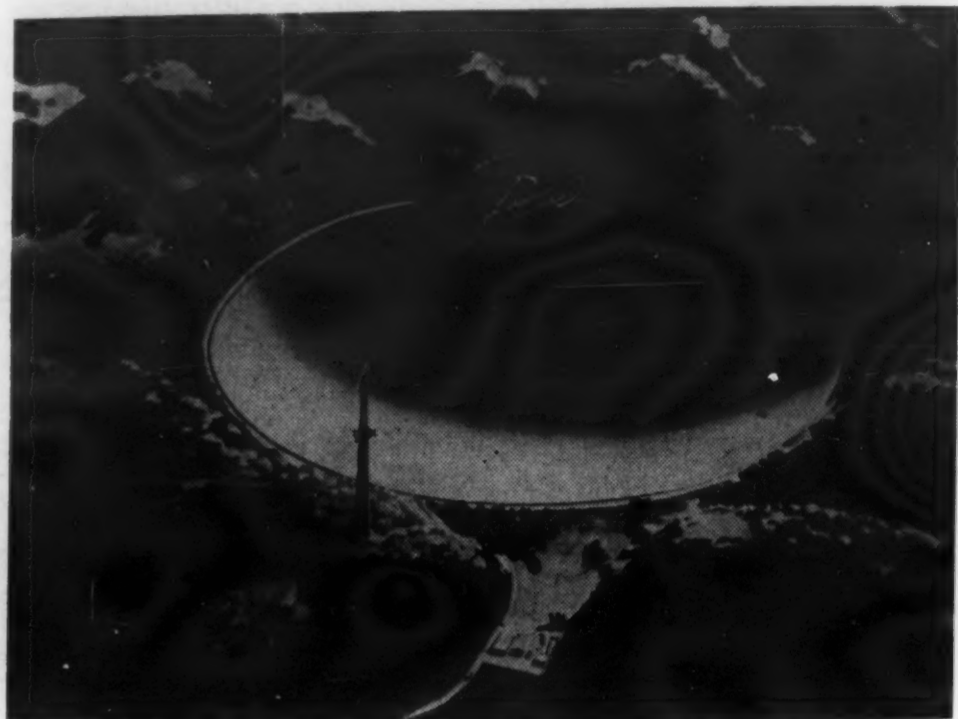
**Rome-Utica**—Lieutenant Colonel Michael Bobela, recently elected chapter president, receives the gavel from Brigadier General Haskell E. Neal, GEEIA Commander. Looking on are L to R: R. C. Benoit, Jr., RADC, 1st vice president; Murray Socolof, Northeastern Blaw-Knox representative, outgoing president; R. E. Harruff, ROAMA, 2nd vice president; J. J. Ward, CESAC, 3rd vice president.



## NEWS ITEMS AND NEW PRODUCTS



The proposed transmitter portion of the 1,000 foot astronomical radio telescope is shown above. The 2½ million watt transmitter, being built by Levinthal Electronics Products, a subsidiary of Radiation Inc., will fill two areas 41 ft. wide by 60 ft. long.



Artist's conception of the astronomical radio telescope to be located at Arecibo, Puerto Rico, shows giant 1,000 ft. reflector and suspended movable line feed assembly.

An astronomical radio telescope consisting of a giant reflector is being developed to aid scientists in their studies of the upper atmosphere, the composition of space and the solar system by radar methods. The project is scheduled for completion in July 1961.

The radio observatory, to be located at Arecibo, Puerto Rico, is funded by the Advanced Research Projects Agency. Construction is under the general direction of Cambridge Research Laboratory (USAF) with Cornell University serving as major contractor. The system utilizes a fixed reflector and a movable line feed to receive or transmit radio signals. The reflector utilizes a large, natural sink-hole as a bowl, and consists of a spherical surface of 870 feet radius, and is designed for a diameter (in plan) of 1,000 feet. The reflector mesh is supported by aluminum members carried by a cable network with frequent supports and tie-downs to maintain the required shape tolerance of plus or minus 0.1 foot from the true sphere.

Radio signals are picked up by a line feed movable on a theoretical paraxial surface 435 feet in radius and extending to a maximum angle of 20 degrees each side of the zenith. The feed structure consists of a fixed triangular support platform and bow-and-arrow type feed system. These latter two units are connected by a circular track for full-circle horizontal movement. The entire feed struc-

ture is suspended from three sets of rigidized cables which are saddled on top of concrete towers and anchored to a concrete base on rock. The development of rigidizing or prestressing the cables makes it possible to meet the maximum deflection tolerance of plus or minus 3 inches for the suspended structure under temperature, wind and structural loads.

Estimated cost of the project is \$3.2 million for the reflector and feed system, with the over-all project cost about \$6,000,000. The engineering design and supervision is by joint venture of von Seb, Inc., Developmental Engineering Corp., Severud-Elstad-Krueger Associates and Praeger-Kavanagh. The design of the line feed is by Technical Research Group, Inc., and is based on a principle worked out by the Cambridge Research Laboratory. Facilities associated with the antenna are being constructed by the U. S. Army Corps of Engineers.

Levinthal Electronic Products, a subsidiary of Radiation Incorporated, is under a \$580,000 contract from Cornell to build the powerful transmitter for the radar installation. The transmitter will produce 2½ million watts of peak power and 150 thousand watts average power at approximately 430 megacycles, and has a pulse length and repetition rate widely variable over ranges of 500.1. The transmitter will be housed in an

area approximately 41 feet wide by 60 feet long by 25 feet high.

• • •

**Exports of electronic products** to the United States from Japan during the first 3 months of 1960 declined seasonally to approximately \$16 million from the volume reached in the last quarter of 1959, though they were almost double the level of the first quarter of last year. The Electronics Division, Business and Defense Services Administration, U. S. Department of Commerce reports that the seasonal nature of the decline is demonstrated by the fact that radio receivers made up ¾ of the total exports to the U. S., and domestic sales of radio receivers always decline in the months immediately following Christmas.

During 1959, the total value of all Japanese exports of electronic products to the U. S. rose steadily from \$8,299,000 in the first quarter to \$29,476,000 in the Oct.-Dec. period. First quarter electronics shipments to this country this year of just under \$16 million featured substantially higher sales of several products than took place during the entire year 1958. Among the large gainers were receiving tubes and transistors, speakers and "sound recorders and reproducers."

A comparison of 1960 shipments of these products with the corresponding 3 months of 1959 shows the following increases: Receiving tubes, up 383 percent; speakers, up

# TELEVISION

## The Principal TASO Findings on

### June PROCEEDINGS presents an exclusive report of world-wide significance

IRE is proud to present, in June 1960 Special Issue of PROCEEDINGS, the findings of a team of 271 engineers who for 2½ years conducted studies of world-wide significance for the future of television. The *Television Allocations Study Organization*—formed by the TV industry in 1956 at the FCC's request—has exhaustively analyzed the engineering factors underlying allocation of frequencies for VHF and UHF television broadcasting.

As the number of television services grows, a better use of TV channels becomes increasingly important. TASO engineers first drew up specifications for measuring TV field strengths; then sifted data on field strengths of VHF and UHF. They have discovered reasons for hitherto unexplained deviations, and have also sought to establish a relation between field strength and picture quality.

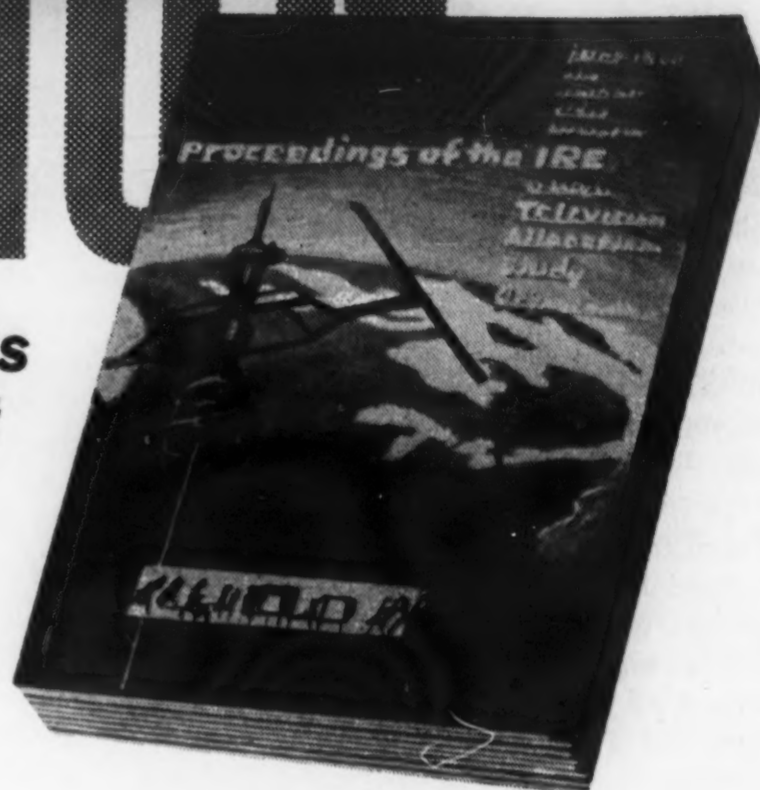
How good are directional TV transmitting antennas? The results of extensive field tests are analyzed. To what extent do interfering signals and noise affect picture quality? How accurately can one predict an interfering field? These and other questions are answered.

So important are the TASO findings that IRE has allocated 120 pages to them. If you are not already an IRE member, we suggest you send in the coupon below to reserve a copy, for the June 1960 PROCEEDINGS will surely remain the definitive work on VHF and UHF TV for many years to come.

#### List of contents:

##### BE SURE YOU READ THESE ARTICLES!

- "Television Allocations Problems" by E. W. Allen, Federal Communications Commission
- "The Television Allocations Study Organization"—a Summary of its Objectives, Organization and Accomplishments" by George R. Town, exec. dir. of TASO; Iowa State University
- "Measurement of Television Field Strengths in the VHF and UHF Bands" by H. T. Head, A. D. Ring and Associates; and Ogden L. Prestholdt, CBS-TV
- "Forecasting Television Service Fields" by Alfred H. LaGrone, University of Texas
- "Influence of Trees on Television Field Strengths at Ultra-High Frequencies" by H. T. Head
- "Tropospheric Fields and their Long-Term Variability as reported by TASO" by Philip L. Rice, National Bureau of Standards
- "Picture Quality—Procedures for Evaluating Subjective Effects of Interference" by G. L. Fredendall and W. L. Behrend, RCA Labs.
- "Measurement of the Subjective Effects of Interference in Television Reception" by Charles E. Dean, Hazeltine Research Corp.
- "Studies of Correlation between Picture Quality and Field Strength in the United States" by C. M. Braun and W. L. Hughes, Iowa State University
- "Relative Performance of Receiving Equipment as reported by TV Servicemen" by Holmes W. Taylor, Burroughs Corp.
- "VHF and UHF Television Receiving Equipment" by William O. Swinyard, Hazeltine Research Corp.
- "Findings of TASO Panel I on Television Transmitting Equipment" by H. G. Towlson of General Electric Co. and J. E. Young, RCA
- "Determining the Operational Patterns of Directional TV Antennas" by F. G. Kear, of Kear and Kennedy, and S. W. Kershner, of A. D. Ring and Assoc.
- "Sound-to-Picture Power Ratio" by Knox McIlwain, Burroughs Corp.
- "Presentation of Coverage Information" by D. C. Livingston, Sylvania Electric Products, Inc.
- "The Television System from the Allocation Engineering Point of View" by Robert M. Bowie, Sylvania Research Labs.



#### THE INSTITUTE OF RADIO ENGINEERS 1 East 79th Street • New York 21, N. Y.



- ☐ Enclosed is \$3.00.
- ☐ Enclosed is company purchase order for the June, 1960 issue on Television.

All IRE members will receive this June issue as usual. Extra copies to members, \$1.25 each (only one to a member).

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233 percent; sound equipment, up 301 percent; and, transistors, up 1059 percent.

• • •

The Navy has announced that preliminary analysis of the results of orbit computations made with data from the Transit I-B satellite has substantially confirmed that the gravitational field in the northern hemisphere of the earth is different from the field in the southern hemisphere.

The confirmation of the asymmetry of the gravitational field of the earth, relative to the equatorial plane, resulted from an analysis of successive orbits which best fit the observations made on the Transit I-B satellite during a period of two weeks. By comparing the Doppler signals received from the satellite with the results of numerical integration of the equations of motion of the satellite obtained on the Naval Ordnance Research Calculator (NORC) it has been possible to establish the orbit with such accuracy that the effect of the asymmetry in the gravitational field was noticeable.

This variation in the strength of the gravitational field has led to the concept of a pear-shaped earth, first noted by Dr. J. A. O'Keefe and associates of the National Aeronautics and Space Administration from analysis of data obtained from the Vanguard I satellite. The independent confirmation of the effect by two Navy scientists, Dr. C. J. Cohen and Mr. R. J. Anderle at the Naval Weapons Laboratory, Dahlgren, Virginia, is of particular interest to astronomers, not only because the Transit I-B satellite is in an orbit having a different height, eccentricity and inclination from that of Vanguard I, but also because the basic methods of orbit observation and data reduction used in the Transit system were different from those used by Dr. O'Keefe.

The satellite orbit information used in this study was obtained by the Transit system which is under development by the Applied Physics Laboratory of The Johns Hopkins University for the U. S. Navy. The Transit system will provide the Navy and the merchant marine with a method of precise all-weather navigation.

• • •

An unusual solar disturbance was observed by the National Bureau of Standards on June 9, 1959. An extremely severe radio blackout of long duration occurred without the expected coincident solar flare. This occurrence is considered an anomaly

of major importance as it does not fit the previous understanding of the associations between solar events, ionospheric disturbances and geomagnetic storms.

The blackout and large radio noise outbursts on a number of wavelengths began at 1630 hours, UT. As soon as the severity of the blackout became apparent, radio and optical observations were intensified. The initial position of the radio-burst source on the sun's disk was established, by high resolution scan at 10.7 cm, to be N 24, E 90. In the light of the H-alpha spectral line, only jets and bright loops were observed at this position. It was not until almost 1½ hours after the first event that the expected H-alpha flare became observable at N 19, E 90. Ordinarily the flare is seen at the same time as the radio disturbance is observed.

Complete blackout of the Bureau's radio station, WWV, occurred at a number of receiving locations. Cosmic noise absorption of an outstanding nature was evidenced by the great drop-off in received signal strength and also by the unusually slow onset of the absorption. Solar radio bursts at 18 Mc were classified as 3 + in importance, and bursts at high frequencies (4.3 mm, 10.7 cm) were very strong. These observations classify the ionospheric events as of relatively great importance.

The solar event of June 9 has forced a critical re-appraisal of past techniques of observation and earlier conclusions from data. The resulting inquiry can be expected to lead to increased understanding of the relationships between the individual components of associated solar events and a consequent improvement in radio propagation prediction methods.

• • •

The first amateur radio moon-bounce between two distant points took place last July 21. Two-way microwave communication via the moon was made between the members of the Eimac Radio Club in San Carlos, California and Sam Harris, Rhododendron Swamp VHF Society, Medfield, Massachusetts.

After months of effort by the radio amateurs concerned, signals were transmitted in both directions on 1296 mc on Sunday, July 17. The equipment was then refined and the first successful two-way communication was made Thursday morning between 7:30 and 8:00 A.M., Pacific Daylight Time. The first transmission was from West (W6HB) to East (W1BU), the pattern was then

reversed and the first amateur coast-to-coast communication via the moon completed. At each end of the circuit, a 1000 watt klystron was used in the transmitter and a very sensitive parametric amplifier in the receiver.

• • •

Twenty-five examples of outstanding product design in electronics as selected by a jury of industrial designers made up the second annual Industrial Design Awards program at the 1960 Western Electronic Show and Convention, (WESCON) held in Los Angeles August 23-26.

The selections included a "family" of four instruments designed for the Decker Corp., Bala Cynwyd, Penn.; the Ampex FR-600 magnetic tape recorder/reproducer; a Beckman Laboratory potentiometric recorder; Librascope's RPC 4000 electronic computing system; The Eitel-McCullough X762B power triode; a precision standing wave detector by DeMornay-Bonardi. Also included were the Beckman 210 high-speed data processing system; the N-2 signal generator produced by Southwestern Industrial Electronics Co.; the Bendix G-20 data processing system; General Electric's 312 digital control computer; the Minicom CM-100 video band recorder; Ramo Wooldridge's standard cabinet design; the Librascope 210 XY plotter; P. R. Mallory's voltage reference battery; a Voltron voltmeter; a traveling wave tube produced by Huggins Laboratories; a Hewlett-Packard variable attenuator; an Eimac X778 traveling wave tube; an Amphenol micor mod connector; an XY plotter by Electro Instruments Inc.; a Corning NF fusion-sealed resistor; and, an Ampex TM-1 digital tape handler.

• • •

Vector Manufacturing Co., Inc., Southampton, Penn., has designed a transistorized commutator for simultaneous sampling of millivolt and volt signals and embodying a modular concept. The commutator is available for sampling high level or low level inputs and is designed for synchronized and simultaneous sampling of intermixed high and low level inputs. A wide range of sampling speeds in excess of 25,000 pps, are available for PCM, PDM and PAM commutation systems. Due to the absence of back current, no specialization of transducer loading effects is necessary.

The Vector Hilo plexer consists of a timer, high level gates (single ended input switches which transfer the information from the transducer to a common output load when the information varies between 0 and 5

volts), low level gates (double ended input switches which transfer the information from the transducer to a common output load), and a low level amplifier which is a differential amplifier which amplifies and converts the dual output of the low level gates, into a single ended pulse train in the 0 to 5 volt range.

• • •

**A 40-foot van** houses a mobile data processing system that can receive analog information from a missile and process and record the information in digital form ready to feed into a computer.

This system may be transported anywhere that roads exist and may be operated from electrical power derived from mobile diesel engine driven generators. The van is provided with a control console which is divided into three sections. The system is designed to accommodate up to 216 input data channels. These analog signals of varying character are conditioned to make them compatible with each other. The signals are then converted into digital form and recorded on magnetic tape. The recorded digital information may be transmitted immediately by wire line or radio to a distant computer. Or, the information may be left stored on tape, ready to be played back whenever required.

A 60-channel bar graph oscilloscope at the control console provides personnel with continuous information about missile performance. Input information may be derived from transducers of various types including variable reluctance, d-c bridge, potentiometer, thermocouple, acoustic, etc. The system will accommodate both a-c and d-c analog input signals, which can be routed into the rest of the system as desired at a patch panel. After conditioning, 59 data channels are commutated and converted into digital form compatible with the requirements of the IBM 704 computer. These 59 channels, plus one timing channel are further processed and recorded on magnetic tape. Any 20 of the 60 channels may be selected for print-out in tabular form. Every sample of all 20 selected channels may be printed out, or by setting a selector switch appropriately, every 10th, 50th or 100th sample of each channel will be typed out. These samples occur at 0.1, 1, 5 and 10 second intervals.

The mobile data processing system was developed and fabricated for the Army Ballistic Missile Agency facility at Redstone Arsenal in Huntsville, Alabama by Consolidated Avi-

onics Corporation under the technical direction of Carl Pilnick, vice president of the firm.

According to Harry R. Glixon, president of the firm: "Although it is too early to determine the actual dollar savings made possible by the use of this mobile data processing system, it is apparent that substantial missile test cost reductions can be realized by minimizing the amount of permanently installed equipment ordinarily required at each missile test site. Perhaps even more important is the saving in time made possible by its mobility. More tests can be conducted at more sites, using the same data processing equipment."

• • •

**The IBM Space Computing Center** in Washington, D. C. recently provided a dramatic black-light display of U. S. space programs to show the public what has been accomplished and a glimpse of what is to come.

The display ranged from scale models of U.S. and U.S.S.R. rockets and satellites to an animated three-dimensional space-ship landing on Mars. In the latter, the audience theoretically stood 200,000 miles above the earth on a platform floating in space. By means of black-light and special effects, the illusion of the universe was created with galaxies of stars, constellations and planets.

At a special preview, guests were shown a milestone in the development of the world-wide tracking system for NASA's Project Mercury. Messages were transmitted from NASA's Space Flight Station at Wallops Island, Virginia, directly into an IBM 709 computer at the Space Center without human intervention. IBM computer scientists also simulated the planned tracking of a Mercury capsule across the Bermuda radar range over the Atlantic and past the Canary Islands. Simulated progress of the capsule was charted on a large map.

After touring the exhibit, Dr. T. Keith Glennan, Administrator, the National Aeronautics and Space Administration, stated in part: "... it points up the complexity and magnitude of space science and exploration. The exhibit is also a fine demonstration of the kind of inter-relationships that must exist among scientists, industry and the government if this nation is to be successful in its space program."

• • •

**A new data storage** and display system, called RASTAD has been developed by the Laboratory for Electronics, Inc. of Boston.

A RASTAD system consists of from 1 to 33 high density magnetic file drums containing 300 tracks on each drum, a symbol generator which simultaneously generates each of the alphanumeric and abstract characters required in report, map, chart and other abstract displays, a master viewer and control console plus as many associated viewing consoles as required, and the necessary associated electronic controls and power supplies. Each file drum has a storage capacity of 1.7 million alphanumeric characters, giving a 33 drum system a total storage capacity of some 55 million alphanumeric characters.

Access to any stored information is achieved in two-tenths of a second. The system read/write rate is 20,000 characters per second—identical with the display rate of the display equipment. A complete display consists of a maximum of 12,800 characters. A complete operation from the pressing of the start key to a completed visual display is accomplished in less than 2 seconds. The display may be erased immediately or retained for up to 20 minutes if desired.

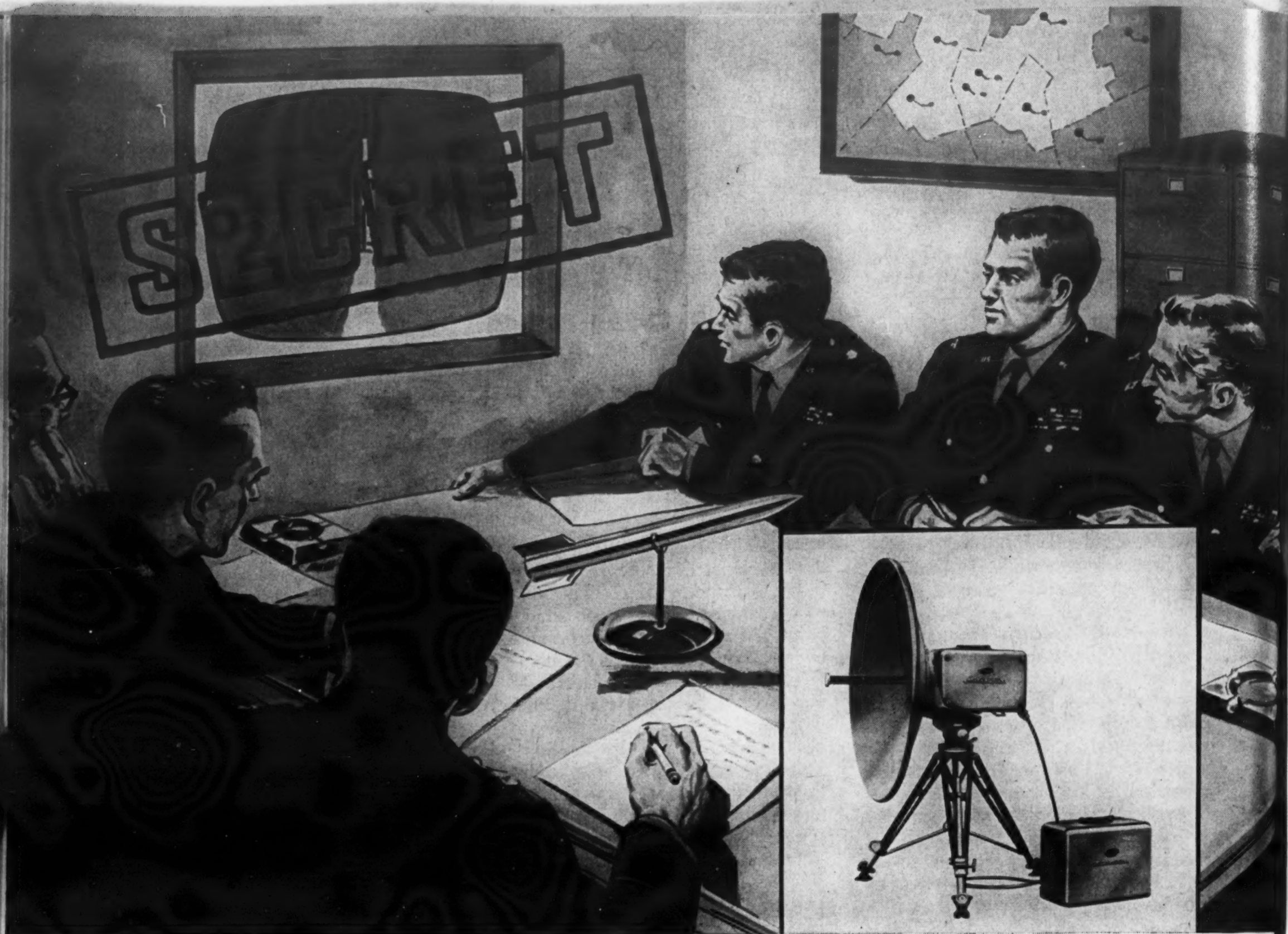
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**The internal communications system** engineered by Dictograph Products Inc. for the Dental Clinic at Lackland Air Force Base, Texas, was designed as a test installation to serve as a model for Air Force Dental Clinics throughout the world.

One of the outstanding features of the now universally-adopted Lackland system is a special foot treadle connected to a wall-mounted speaker microphone which permits the dentist to continue working while answering or originating a call.

Installed in nine operating rooms at Lackland AFB, these instruments are capable of receiving announcements directly from the receptionist without the necessity of manual operation on the part of the dentist. Nine other wall-mounted operating room stations, also provided with this latter convenience, are equipped with pushbuttons with which to signal the receptionist and a chime signal to announce incoming calls.

The receptionist is furnished with a central station which enables her to contact each of the other stations instantly by merely depressing the appropriate key. The central station is also equipped with a switching mechanism which permits the placement of two or more simultaneous calls without the intermediate aid of any other station. Incoming calls are announced by a chime and a visual signal.



## New Microwave For Secure TV and Radar Relay

The widest band microwave equipment made today comes from Raytheon, world's largest manufacturer of microwave tubes and equipment. It is designated KTR 1000G (FS) and operates in the 5925 to 7425 Mc range.

This equipment is suitable for high-information pulse data transmission such as secure TV. It is also capable of transmitting from a radar site to a remote indicator, images of the highest definition possible today in a radar relay.

KTR 1000G (FS) is one more example of Raytheon's capability to develop

advanced microwave systems for military engineering agencies and their suppliers.

### SPECIFICATIONS

|                  |                            |
|------------------|----------------------------|
| Bandwidth        | Output                     |
| 12 Mc            | 1-Watt Klystron            |
| Rise Time        | Package                    |
| 0.035 $\mu$ sec. | Rugged, Lightweight Design |
|                  | Color                      |
|                  | Field Sequential or NTSC   |

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**EQUIPMENT  
DIVISION**

*Excellence in Electronics*

The Henry Francis Parks Laboratory of Seattle, Washington has published a pamphlet describing moisture and its measurement. Free copies are available upon request to P. O. Box 1665, Lake City Station, Seattle 55, Washington.

The Model No. 9322 Antenna Coupler designed by Bogart Manufacturing Corp. of Brooklyn, fastens over the radome of a radar system and operates as a pre-flight checker. The performance monitor covers a frequency range of 1000-11,000 Mc/s.

The monitor matches out counter-measure antennas of all types including helix's spiral and scimitars and also provides a calibrated signal of 40 db  $\pm$  2.5 db over a frequency range in excess of 10,000 megacycles.

A digital data system that will provide direct visual readout and printed records of the position of a radio astronomy telescope has been designed and built by Datex Corporation, Monrovia, California, for the Air Force Cambridge Research Center. The system is in use at the Center's Sagamore Hill 84-foot radio telescope.

Computer pre-punched tape supplies data for the required antenna position. The visual displays permit comparison between the actual and required antenna positions. Additional components can be added to automatically indicate actual performance of the antenna relative to its command. Also the system may be converted to control the antenna position by commanding it to follow a given course.

The Datex system has been designed as a group of subsystems. The first, consisting of a high-speed optical tape recorder, programmer, a Greenwich-Mean-Time (GMT) clock, storage translators and light banks, will search the punched paper tape to find the day, hour, minute and second shown on the GMT clock. When this is determined, the system reads the succeeding interval information off the tape into the associated storage translators and displays this information on the light banks.

Shaft encoders and storage translators comprise the second subsystem and provide digital information of the antenna hour angle and declination. The third subsystem takes the output from the various portions of the system and selects these in proper sequence for recording on a Data/Log printer, which will print one

complete unit of information from the system every ten seconds.

The annual meeting of the Association of the U. S. Army was held on August 8-10. The Honorable Wilbur M. Brucker, Secretary of the Army, delivered the Keynote address, entitled "The Army Today." The Secretary outlined the progress the Army has achieved in the last year in a number of areas, including the "One Army Concept," modernization, airlift and ICBM defense.

A highlight of the first day was a talk by General Dr. Hans Speidel, Commander, Allied Land Forces, Central Europe. For three years General Speidel has had this command, which includes our Seventh Army in Germany as well as all other NATO ground forces. He stressed the importance of ground forces and emphasized the fact that the Soviets rely heavily on their ground forces, to be used in the long struggle following an initial atomic attack.

Of interest to SIGNAL readers was a talk by Major General Earle F. Cook, Deputy Chief Signal Officer. He covered developments in two areas of Signal Corps responsibility, communications and surveillance/target acquisition. In addition, General Cook discussed changes in system implementation procedures designed to shorten the drawing-board-to-user delay.

Word of a new study called MOMAR, MODern Mobile ARmy, was released at the AUSA meeting. The actual document is classified, but its purpose and general concepts were announced. Its purpose is to provide a plan, to be updated each year, for the development of the army in the 1965 to 1970 period. The plan makes recommendations for reorganization based on equipment expected to be available by that time. Generally it extends the Pentomic concepts, anticipating better communications, more mobility and other developments. The study calls for reorganization of each unit, from the squad to the division. The administrative support organization would also be reorganized by combining the various service support units under one commander at the division level.

Lt. Gen. E. R. Quesada, USAF (Ret.), spoke at the Annual Honors Luncheon of the Army Aviation Association of America. This luncheon, held on the first day of the AUSA meeting, made a number of awards including the Hughes Army Aviation Trophy, awarded this year for the first time by the Hughes Aircraft Company. The Honorable Courtney

Johnson spoke at the Sustaining Member luncheon.

The final event of the meeting was the General George C. Marshall Memorial Dinner. The Honorable Robert A. Lovett, former Secretary of Defense, spoke of his association with General Marshall.

## Photoprogress

Photodrawings, a concept in which photography and line drawing are combined, are described in a new four-page bulletin published by LogEtronic, Inc., Alexandria, Virginia. Assembly drawings, instruction manual illustrations, design modifications and maintenance instructions are discussed in terms of the specific advantages of the photodrawing approach.

The bulletin gives the step-by-step production of photodrawings with LogEtronic photographic enlargers, which make possible the required detail reproduction and contrast control necessary for conventional diazo or blueprint reproduction.

Copies of Bulletin B-10M3 may be obtained by writing LogEtronic, Inc., 500 East Monroe Ave., Alexandria, Va.

Chicago Aerial Industries, Inc. of Melrose Park, Illinois has announced the development of a rapid processing system that develops roll film within thirty seconds, and of a rapid processing attachment for aerial cameras that develops film in the camera in two minutes.

The attachment system uses a single solution containing developer and fixer which is used to impregnate a specially prepared web. As the film is exposed the web is pressed to the film and immediately begins developing. Within two minutes after the last picture is taken the negative film is ready for viewing.

A photograph taken by the Princeton University astronomy team headed by Dr. Martin Schwarzschild shows for the first time white gaseous dots within the umbra of a sun spot. The photograph was taken on the final balloon-borne telescope-camera trip of Stratoscope I, September 24 1959, near Minneapolis, Minn.

Because sun spots are more than 1000° cooler than the sun's surface, or photosphere (whose temperature is about 5700°K), they consequently produce much less visible light. A different film was used in the telescope-camera during the final flight to bring out the characteristics of

the umbra while "washing out" the typical granulations surrounding the spot.

"We can now see plainly that there are bright dots in the umbra," said Dr. Robert Danielson, member of the Princeton team. "While we do not yet know much about them, we know that they are very small—less than 200 miles in diameter. There is a possibility that they are convection cells somewhat like solar granulations, but strongly suppressed by the magnetic field of the sun spot. Much detailed analysis remains to be done before we can make conclusions about their characteristics."

A new camera, for use in eye movement studies, records a continuous picture of what an observer sees. Superimposed on the picture is a white dot showing the eyes' exact center of attention. The device is described as useful for evaluating instrument panel layouts and other product designs and for testing reactions under stress.

The 5½ pound Westgate-Mackworth Eye Movement Camera is adjustable to any head size and consists of an optical system that transmits corneal reflection, plus what the observer sees, to a motor driven 8 mm movie camera. Filming speed is adjustable from 4 to 8 frames per second; the magazine contains 25 feet of film. Field diagonal is 28°40'; objects to be viewed may be from 2 to 4 feet away. Other viewing distances are possible with a lens adjustment made at the factory. The camera, developed by the Westgate Laboratory, Inc. of Yellow Springs, Ohio, photographs the over-all scene through a beam splitting mirror. Simultaneously, a periscope carries a spot of light reflected from the cornea to the camera; the spot moves as the eye explores the scene. The exact synchronism of spot location and eye attention-point is achieved through optical inversion and compensation.

During their continuing painstaking analysis of the more than 20,000 photographs taken by Tiros I, Weather Bureau satellite meteorologists of the Department of Commerce discovered an unusual picture showing an isolated group of clouds appearing as a very bright square in an otherwise cloudless part of the sky. The photograph was taken by Tiros on May 19 over the Southern Plains area of the U. S., two hours before tornadoes and hailstorms broke out near the Texas-Oklahoma border.

This information stimulated the

Weather Bureau scientists to explore the possibility that cloud masses similar to this one might represent the incipient stages of a severe weather system. In the detailed meteorological analysis that followed, a positive identification was made of the features of the photograph by their comparison with other weather observations taken at that same time. From cloud analysis and locations obtained through the use of a cloud schematic, the "square" cloud mass was determined to be precisely in the area of heavy thunderstorm activity reported by the Texas cities of Hobart, Childress and Wichita Falls at the exact time the Tiros wide angle camera snapped the picture. The analysis also produced strong evidence that this cloud mass later expanded and spread northeastward, spawning tornadoes and hail in central Oklahoma.

Weather Bureau satellite meteorologists hasten to add that this discovery must be considered a stroke of luck. Not every isolated cloud mass seen from satellite vehicles will warn of impending severe weather. However, in the future, detection of unusual cloud masses, when considered with the geographical location, the climatology of the region and the existing weather situation may well enhance the meteorologist's ability to recognize and pinpoint impending small-scale severe weather situations.

The Society of Photographic Scientists and Engineers will meet in Washington, D. C., October 14 and 15. Objective of this meeting will be the exchange of information on short access time, compact, simplified photographic processing equipment.

Dr. Edward K. Kaprelian, assistant director of research, U. S. Army Signal Research & Development Laboratories, Fort Monmouth, N. J., will preside at several key sessions and will speak on the subject, *Future Military and Commercial Applications of Short Access Time Rapid Processing*. George T. Eaton, SPSE president and head of Eastman Kodak's processing research department, will keynote the symposium. He will give a paper on *The Revolution in Photographic Processing*.

## Names in the News

J. Paul Walsh has been appointed director of the Corporation for Economic and Industrial Research's (CEIR) Arlington Research Center. Before joining CEIR in February, he was systems manager, Federal Systems

Division, International Business Machines Corporation.

Col. Sidney S. Davis is retiring from military service. He was professor of military science and tactics at Northeastern University since December, 1958, and previously at the University of Maryland.

George R. Lawrence has been appointed sales manager of Sperry Gyroscope Company's Electronic Tube Division. He will be responsible for sales and marketing operations of the division, a source of special electronic tubes for microwave radars and other electronic systems used by the Armed Forces and industry. He joined the firm in 1937.

Donald K. Adams has been appointed Director of Liaison Engineering for the new TransDigital Systems division of Cook Electric Company. Prior to joining TransDigital Systems he was project engineer for the United States Army Electronics Environmental Test Facility.

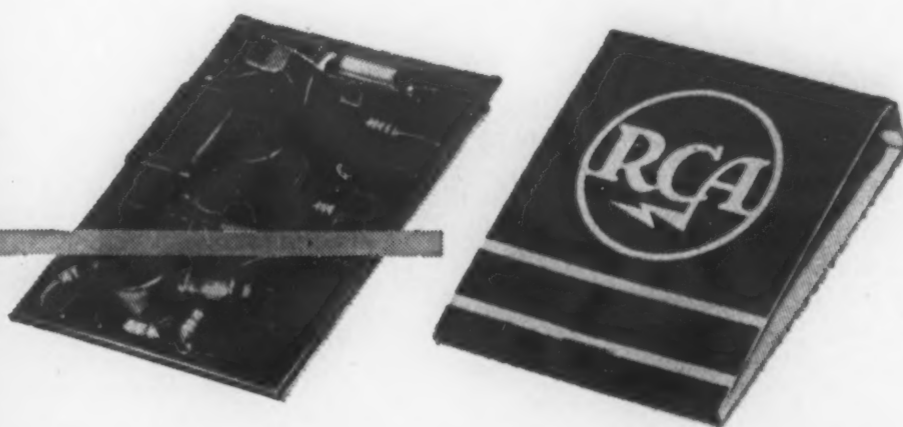
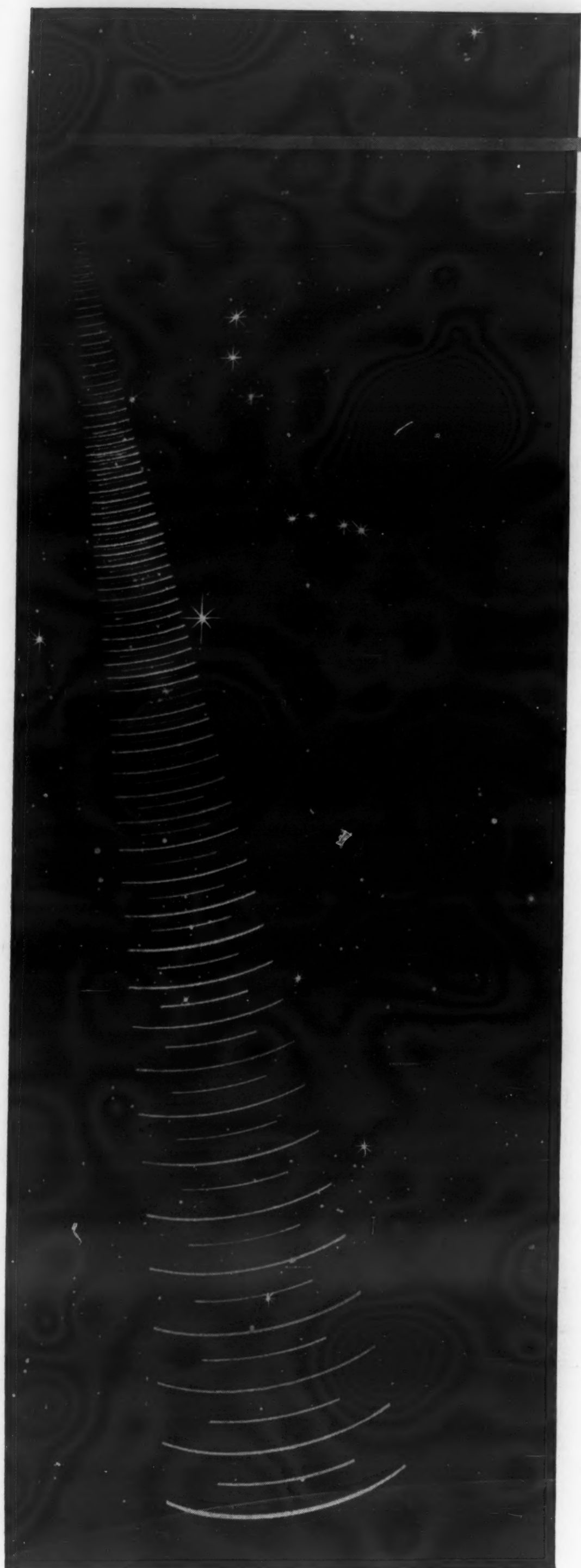
Melvin E. Lowe has been appointed marketing manager of the Waltham Laboratories of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc. Prior to joining the company, in 1955, he was associated with the Air Force Cambridge Research Center.

W. Walter Watts has been elected chairman and president of the Radio Corporation of America Sales Corporation. He will assume his new duties in addition to his present responsibilities as group executive vice president. He previously had executive responsibility over the Home Instrument, RCA Victor Distributing Corporation. Mr. Watts is a permanent director of AFCEA.

Thomas J. Hargrave was re-elected as chairman of the board of directors of Eastman Kodak Company. M. Wren Cabel, vice president of Eastman Kodak Company, was advanced to general manager. He had been assistant general manager of the company.

Thomas C. Clark was appointed a vice president of Houston Fearless Corporation. He will continue his former position as vice president and general manager of the company's Houston Fearless Division in Los Angeles.

John N. Glover has been appointed district manager in Stromberg-Carlson's Colorado Springs, Colorado, office. He was previously with General Electric Company for five years as a field engineer and district representative with the Light Military Electronics Division, and later as an engineer with the Computer Department.



Radio beacon transmitters no bigger than a matchbook—another RCA contribution to space-age technology.

## Tiny RCA space radios help “ECHO” scientists find a pinpoint in the sky

The pinpoint is the 100-foot aluminized plastic balloon now orbiting about a thousand miles above the earth. Its purpose: to establish the feasibility of long-distance communications by bouncing radio waves off an object in space to distant points on the earth's surface.

The balloon carries two RCA radio beacon transmitters, each scarcely larger than a matchbook, yet capable of being heard for two thousand miles or more. They send signals earthward, telling scientists where to find the balloon at night or when clouds obscure the sky. Because the radios are sun-powered, they are expected to broadcast throughout the life of the balloon satellite.

These amazing radio transmitters were designed and built by the Astro-Electronics Division at RCA's Space Center at Princeton, N. J.—birthplace of the satellite and ground-based radio equipment for the “Talking Atlas” satellite, the TIROS “weather-eye” satellite system, and other space-age achievements.

This program—called “Project ECHO”—is sponsored by the National Aeronautics and Space Administration as the first step towards a new system of global communications. Eventually, television programs may be viewed around the world through the use of these orbiting “radio mirrors.”

The same RCA engineering and manufacturing skills that are helping man conquer space assure the dependability of the RCA Victor black-and-white and color television sets, radios and high-fidelity systems you enjoy in your home.



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RADIO CORPORATION OF AMERICA

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## Chapter News

(Continued from page 59)

there was a question and answer period.

At the meeting on May 11, at the Benjamin Franklin Hotel, members and guests heard a talk on "The Excessive Cost of Exotic Specification." It was given by Captain John C. Walter, USNR, manager, High Power Nucleonics Engineering, Radio Corporation of America, Camden, New Jersey. "Silent Sentinels" and "The Lebanon Incident," Navy films, were shown following the talk by Captain Walter.

Election of officers also took place at the meeting. Those elected were: president, Roy Pace, Pacific Telephone and Telegraph Company; vice president, Rear Admiral H. H. McCarley, USN (Ret.), Boeing Airplane Company; secretary, Wike E. Cruse, U. S. Office of Civil and Defense Mobilization; treasurer, Eugene Gunther, West Coast Telephone Company. Elected as trustees were: Lee David, Boeing Airplane Company; James E. Parrott, Pacific Telephone and Telegraph Company, retired; Alfonso A. Baird, Western Union Telephone Company; Phil H. Stewart, Alaska Communication System, Russell E. Winslow, Boeing Airplane Company.

### Tinker-Oklahoma

The chapter has elected new members to serve for 1960-61. Those elected are: president, Bob Howard; first vice president, Lawrence A. Trautman; second vice president, Major James W. Rogers; third vice president, E. K. Poterfield; fourth vice president, Colonel Harry A. French; secretary, George Billy; treasurer, Bill Cook; board of directors, James Ellison, A. P. Gilbert, Bill Kitchen, Eric Gilmore, Jack Lovell, Jim White, Ansel Challenner, D. F. Holaday, Fritz Villines.

### GLOBECOM IV

(Continued from page 44)

system would be particularly useful for transatlantic submarine cable systems where the cost prohibits the construction of many such systems.

At the tropospheric communications session, operational considerations of Project Dew Drop were outlined. Project Dew Drop is a long range communications system, based on the use of U.H.F. multichannel single sideband scatter equipment. The system is being used with the Air Force AIRCOM system. Though already having rendered successful performance, Dew Drop can only be regarded as a first milestone for long range single sideband tropospheric communications.

The symposium was sponsored jointly by the IRE and the U.S. Army Signal Corps.

National Headquarters will replace any damaged copies of the August issue.

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## INDEX TO ADVERTISERS

|  |           |  |           |
|--|-----------|--|-----------|
| Adler Electronics, Inc.                                  |           | Phelps Dodge Copper Products                                   |           |
| Zam and Kirshner, Inc.....                               | 1         | Compton Adv., Inc.....   | 15        |
| Alden Electronic & Impulse Recording Equipment Co., Inc. |           | Phileo Corp., Government & Industrial Div.                     |           |
| Molesworth Associates .....                              | 4         | Maxwell Associates, Inc.....                                   | 57        |
| Alpha Corp.  |           | Prodelin, Inc.   |           |
| Don L. Baxter, Inc.....                                  | 10, 11    | Josephson, Cuffari & Co. ....                                  | 44        |
| Automatic Electric Co.                                   |           | Radiation, Inc.  |           |
| Kudner Agency, Inc.....                                  | 32        | G. M. Basford Co.....  | 3rd Cover |
| Bomac Laboratories, Inc.                                 |           | Radio Corporation of America                                   |           |
| Larcom Randall Adv., Inc.                                |           | J. Walter Thompson .....                                       | 67        |
|  | 4th Cover | Radio Corporation of America, Defense Electronic Products      |           |
| Continental Electronics Manufacturing Co.                |           | Al Paul Lefton Co., Inc.....                                   | 34, 35    |
| Evans, Young, Wyatt Adv.....                             | 2         | Radio Corporation of America, Semiconductor and Materials Div. |           |
| Cook Electric Co., Data-Stor Div.                        |           | Al Paul Lefton Co., Inc.....                                   | 21        |
| Wexberg-Arlen Adv. ....                                  | 6         | Raytheon Co., Equipment Div.                                   |           |
| FXR, Inc.  |           | Hoag and Provandie, Inc. ....                                  | 64        |
| Beecher Associates.....                                  | 2nd Cover | Sylvania Electric Products, Inc.                               |           |
| General Electric Co., Communication Products Dept.       |           | Kudner Agency, Inc.....  | 26, 27    |
| Brooke, Smith, French & Dorrance, Inc. ....              | 9         | Yuba Consolidated Industries, Inc.                             |           |
| General Electric Co., Heavy Military Electronics Dept.   |           | The McCarty Co.....  | 5         |
| George R. Nelson, Inc.....                               | 53        | Western Electric Co., Defense Products Div.                    |           |
| Hoffman Electronics Corp., Military Products Div.        |           | Cunningham and Walsh, Inc...                                   | 42        |
| Honig-Cooper, Harrington & Miner, Inc. ....              | 17        | Westrex Corp.  |           |
| Institute of Radio Engineers                             |           | Fletcher Richards, Calkins & Holden .....                      | 55        |
| Raymond Schoonover Adv.....                              | 61        | Wilcox Electric Co., Inc.                                      |           |
| Magnavox Co.   |           | Valentine-Radford Adv. ....                                    | 30        |
| Rothbardt & Haas Adv., Inc....                           | 49        |  |           |

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Here are several good reasons why an AFCEA-SIGNAL membership is of importance to you. It affords chapter affiliation with friends in the electronics field. It creates a very congenial climate for the members of the civilian-military team to discuss and solve problems of mutual interest.

Secondly, SIGNAL Magazine is a continuing contact with the professions of communications, electronics and photography. It provides its readers with the best information on timely subjects and major developments of professional interest. It gives our advertisers a crystal clear shot to present facts about services, products and achievements to a specialized and interested audience.

Thirdly, the AFCEA Convention guarantees a highly intellectual and top side audience to hear presentations of technical papers and the latest achievements and trends of the future. Members, guests and friends are given an opportunity to view first hand an entire display of products and/or services in an atmosphere of a masterfully coordinated technical trade show.

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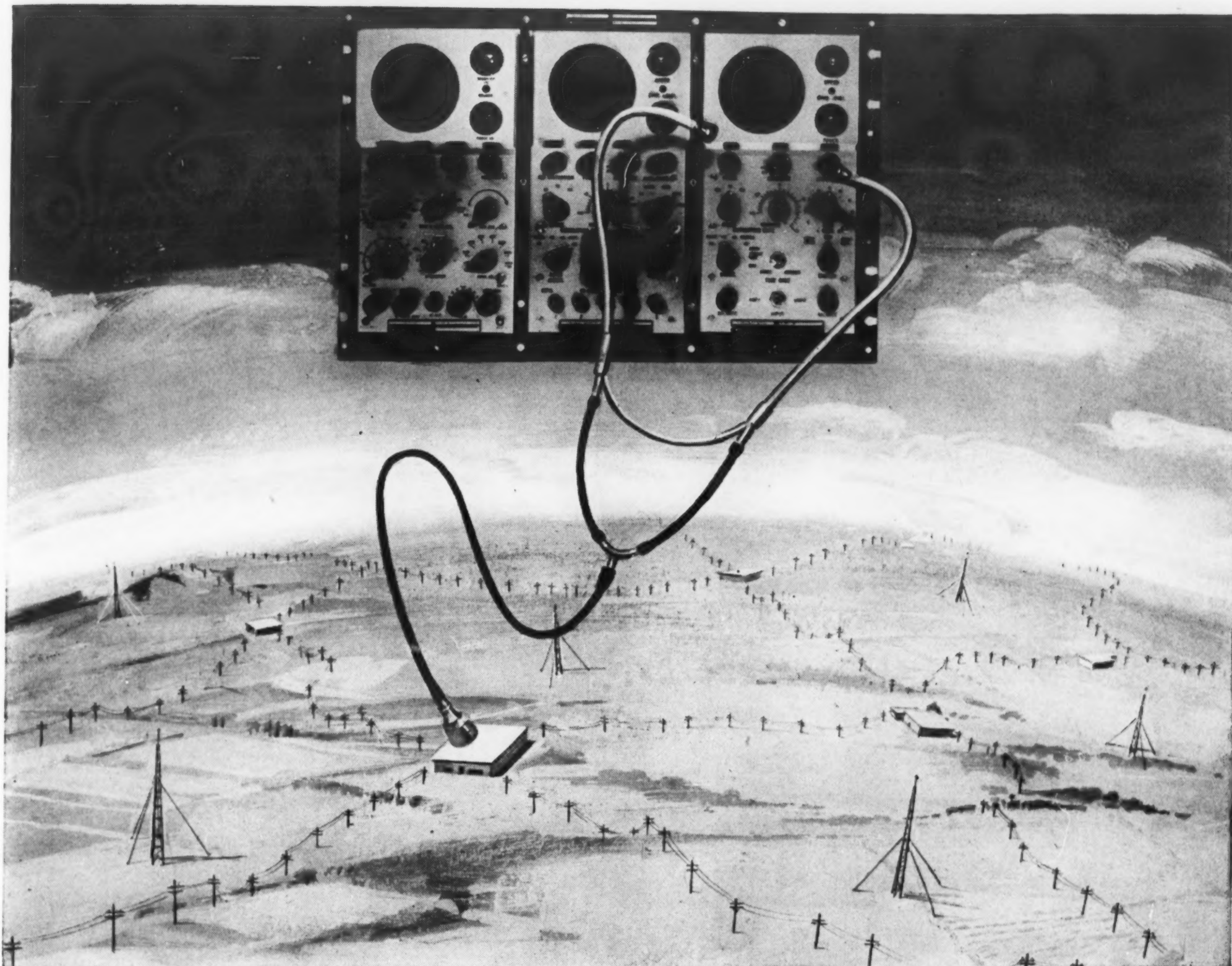
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**telegraph and data transmission systems without interrupting traffic**

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With miniaturized components for space saving compactness, the TDMS can replace most test equipment now required. This permits a reduction of test equipment costs and increases maintenance efficiency. Portability is achieved at the "push of a button."

For complete technical data on the TDMS and its many capabilities, write for Bulletin E-100B to Radiation Incorporated, Dept. S-9, Melbourne, Fla.

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## CRIMEA AND PUNISHMENT

At the height of the famous Charge of the Light Brigade, no less than 23 of the radar's tubes malfunctioned simultaneously. (And no wonder — for this was the year 1856 — 91 years Before Bomac.) The calamity not only left the Light Brigade totally in the dark, but very nearly lost the battle and the radar unit itself. Only the heroic action of an anonymous radio operator, later reported missing, kept the unit from falling into Russian hands.

Many years later, however, there appeared in England a man named Roland Stone, who claimed to be the missing radio operator of Balaklava. He was given a hero's welcome and was scheduled to receive the Victoria Cross for valor. He would have, too — except for a sharp-eyed, hawk-nosed man named Sheerluck Domes who happened to read about Stone in the newspaper.



# BOM

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

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Domes rushed to see the Queen and managed to gain entrance just as Stone was about to receive his reward.

Before the startled Queen could say a word, Domes was flashing a telegraph key under Stone's nose. "If you're a radio operator," he hissed, "send me some code!" Stone stammered for a moment. His hands dropped helplessly to his sides.

"You see, your majesty!" Domes said triumphantly. "This man is no radio operator. He wouldn't know a dot from a dash if he met them in Covent Garden. Off with his head, I say."

After they had led Stone away, the Queen marveled: "But Domes, how could you be sure this man was an impostor? All you knew was his name."

"That," said Sheerluck, "was all I had to know. After all," he went on, "a man named Roland Stone simply couldn't be a radio operator."

"Why not?" asked the Queen.

"Because," the great man said, "a Roland Stone gathers no Morse."



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